RM L55B28

NACA RM L55B28

NACA

RESEARCH MEMORANDUM

EXPLORATORY INVESTIGATION AT MACH NUMBER 4.06

OF AN AIRPLANE CONFIGURATION HAVING

A WING OF TRAPEZOIDAL PLAN FORM

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS

By Robert W. Dunning and Edward F. Ulmann

Langley Aeronautical Laboratory
Langley Field, Va.

NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS

WASHINGTON

April 28, 1955
Declassified September 1, 1961

NACA RM L55B28

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

EXPLORATORY INVESTIGATION AT MACH NUMBER 4.06 OF AN AIRPLANE CONFIGURATION HAVING A WING OF TRAPEZOIDAL PLAN FORM

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS

By Robert W. Dunning and Edward F. Ulmann

SUMMARY

An investigation to determine the longitudinal and lateral control characteristics of an airplane configuration having a trapezoidal wing with modified hexagonal airfoil section and a cruciform tail with 5° semi-angle wedge section has been carried out in the Langley 9- by 9-inch Mach number 4 blowdown jet. Tests on the complete model and on the model with either the upper or lower vertical tail removed were made at a Mach number of 4.06 and a Reynolds number of 2.7×10^{6}, based on wing mean aerodynamic chord. Data were obtained for angles of attack from 0° up to 12° at angles of sideslip from 0° up to 8°. The incidence angles of the all-movable tails were varied from 6° to -8°, which permitted obtaining effective downwash angle as well as control effectiveness. The data are presented with respect to the body axes.

INTRODUCTION

The aircraft configurations previously investigated experimentally at high supersonic and hypersonic speeds have been restricted to missile types which were not required to land, and which therefore had relatively small wings or wings of very low aspect ratio. The purpose of the present investigation was to determine the characteristics of a configuration conforming more closely to a piloted aircraft having a wing area sufficient for conventional landing. Of the various possible configurations, one was selected for this exploratory study which was expected to have satisfactory low-speed characteristics and satisfactory transonic characteristics. This configuration (fig. 1) employs a trapezoidal wing and the arrangement, in general, is similar to conventional airplanes. Two particular features were incorporated which are believed to be desirable for high supersonic and hypersonic operation - relatively large leading-edge radii for both wing and tails, and wedge-shaped sections for the tails. The wing and tail sections were designed with large leading-edge radii because of heat-transfer considerations at high Mach numbers. The wing leading-edge radius, for example, would be approximately 1.5 inches at the wing-fuselage intersection for a full-size airplane having a wing span of about 28 feet. Inasmuch as the effectiveness of lifting surfaces having flat-plate or conventional supersonic airfoil sections decreases considerably with Mach number at high supersonic speeds (ref. 1), the effectiveness of tail surfaces of conventional size utilizing these airfoil sections would be marginal or insufficient at the Mach number of the present tests. Several types of tail airfoil sections therefore are being considered and the present results were obtained with a 5° semi-angle wedge section.

In references 2, 3, and 4, longitudinal and lateral stability data were presented for this airplane configuration and various combinations of its components at Mach numbers of 4.06 and 6.86. Reference 5 presents longitudinal and lateral control data at Mach number 6.86. This report presents the longitudinal and lateral control characteristics at Mach number 4.06 of the complete configuration and of the configuration with either the upper or lower vertical tail removed. The data have been analyzed only to the extent that effective downwash angle and some stability determinants have been obtained.

SYMBOLS

The results of the tests are presented as standard NACA coefficients of forces and moments. The data are referred to the body axes (fig. 2) with the reference center of gravity at 54 percent of the wing mean aerodynamic chord (52.66 percent of the body length from the body nose).

C_N normal-force coefficient, $-Z_B/qS$

C_Y lateral-force coefficient, Y/qS

C_m pitching-moment coefficient about center of gravity, $M'/qS\bar{c}$

C_n yawing-moment coefficient about center of gravity, N/qSb

C_l rolling-moment coefficient, L/qSb

Z_B force along Z_B axis

Y	force along Y-axis
M'	moment about Y-axis
N	moment about Z_B-axis
L	moment about X_B-axis
q	free-stream dynamic pressure
S	total wing area, including area submerged in fuselage
c	wing chord
$\bar{c}$	wing mean aerodynamic chord
c_t	tail root chord
b	wing span
R	Reynolds number based on $\bar{c}$
M	Mach number
α	angle of attack of fuselage center line, deg
β	angle of sideslip, deg
i_H	angle of incidence of horizontal tail relative to fuselage center line, deg
i_V	angle of incidence of vertical tail relative to fuselage center line, deg
ϵ	effective angle of downwash, deg
C_{m_t}	increment of pitching-moment coefficient provided by the tail
n_p	neutral-point location, percent of body length
$\frac{\partial C_m}{\partial C_N}$	rate of change of pitching-moment coefficient with normal-force coefficient

$\frac{\partial C_m}{\partial i_H}$ rate of change of pitching-moment coefficient with horizontal-tail incidence angle

$\frac{\partial \epsilon}{\partial \alpha}$ rate of change of effective downwash angle with angle of attack

C_{Y_β} rate of change of lateral-force coefficient with angle of sideslip

C_{n_β} rate of change of yawing-moment coefficient with angle of sideslip

C_{l_β} rate of change of rolling-moment coefficient with angle of of sideslip

Model designations:

B body

W wing

T_H horizontal tail

T_{VU} upper vertical tail

T_{VL} lower vertical tail

APPARATUS

The tests were conducted in the Langley 9- by 9-inch Mach number 4 blowdown jet, which is described and for which a calibration is given in reference 6. The settling-chamber pressure, which was held constant by a pressure-regulating valve, and the corresponding air temperature were continuously recorded during each run. A sting-mounted internal strain-gage balance which measured normal force, pitching moment, side force, yawing moment, and rolling moment was used to obtain the data.

MODELS

The model configurations used for the present tests consisted of a complete model (figs. 1 and 3) and the model with either the upper or lower vertical tail removed. Details concerning the geometric characteristics of the model and the wing and tail sections are given in table I and figures 3 and 4. The model designations used throughout the report are graphically illustrated in figure 5. The wing has a trapezoidal plan form with a hexagonal section that has been modified by rounding the leading edge to a 1-percent-chord radius and blunting the trailing edge to a 2-percent-chord thickness. The wing has a maximum thickness of 4 percent, and the quarter chord is swept back 29°. The tails have a trapezoidal plan form, 5° semiangle wedge section, and 0.007-inch leading-edge radius. The all-movable tails pivot about axes through the $53\frac{1}{2}$ percent root-chord station of the tail (fig. 3). A photograph of the complete airplane configuration installed in the Langley 9- by 9-inch Mach number 4 blowdown jet is presented in figure 6.

TESTS

The settling-chamber stagnation temperature during any single run varied from approximately 80° to 40° F, and the settling-chamber stagnation pressure was held at approximately 186 lb/sq in. abs. These conditions correspond approximately to a Reynolds number of 2.7×10^6, based on the wing mean aerodynamic chord. The tests were run at humidities below 5×10^{-6} pounds of water vapor per pound of dry air, which is believed to be low enough to eliminate water-condensation effects. The test-section static temperature and pressure did not reach the point where liquefaction of air would take place. Data were obtained for angles of attack from 0° up to 12° at angles of sideslip from 0° up to 8°. The tail incidence angle was varied from 6° to -8°. The tests with varying horizontal-tail incidence were made only at zero vertical-tail incidence and the tests with varying vertical-tail incidence were made only at zero horizontal-tail incidence.

PRECISION OF DATA

The probable uncertainties in the test data due to the accuracy limitations of the balances and the recording equipment and the ability of the system to repeat data points are listed in the table below. The accuracy of the rolling-moment coefficients is low relative to the maximum rolling moment encountered. This is because rolling-moment gages were added to an existing balance which was not originally designed to measure rolling moment.

C_N	± 0.001
C_Y	± 0.0003
C_m	± 0.0004
C_n	± 0.00005
C_l	± 0.0009
α, deg	± 0.1
β, deg	± 0.1

RESULTS

The experimental longitudinal and lateral control characteristics of the configurations are given for all angles of attack and sideslip tested in table II, and representative portions of the data are presented in the figures. Equations for transferring these coefficients from the body axes to the stability axes are presented in the appendix.

The longitudinal control characteristics of the models are presented in figures 7 and 8. Trim longitudinal stability determinants and trim longitudinal characteristics for the complete model are presented in figures 9 to 11. The effective downwash angle was obtained by means of the relation

$$\epsilon = \alpha + i_H - \frac{C_{m_t}}{\partial C_m / \partial i_H}$$

The effects of sideslip angle on the lateral and longitudinal characteristics of the models are presented in figures 12 to 14. Figure 15 presents some lateral stability parameters. The variations of the lateral characteristics with normal-force coefficient are presented in figure 16, and in figure 17 the effect on the yawing-moment coefficient of varying the vertical tail incidence angle is presented.

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., February 16, 1955.

APPENDIX

The equations for the transfer of force and moment coefficients from the body-axis system to the stability-axis system are as follows:

$$C_{Y_S} = C_{Y_B}$$

$$C_{l_S} = C_{l_B} \cos \alpha + C_{n_B} \sin \alpha$$

$$C_{n_S} = C_{n_B} \cos \alpha - C_{l_B} \sin \alpha$$

$$C_{m_S} = C_{m_B}$$

Inasmuch as longitudinal forces were not measured, the axis-transfer equations for lift and drag coefficients are not given here.

REFERENCES

1. McLellan, Charles H.: A Method for Increasing the Effectiveness of Stabilizing Surfaces at High Supersonic Mach Numbers. NACA RM L54F21, 1954.

2. Dunning, Robert W., and Ulmann, Edward F.: Static Longitudinal and Lateral Stability Data From an Exploratory Investigation at Mach Number 4.06 of an Airplane Configuration Having a Wing of Trapezoidal Plan Form. NACA RM L55A21, 1955.

3. Penland, Jim A., Ridyard, Herbert W., and Fetterman, David E., Jr.: Lift, Drag, and Static Longitudinal Stability Data From an Exploratory Investigation at a Mach Number of 6.86 of an Airplane Configuration Having a Wing of Trapezoidal Plan Form. NACA RM L54L03b, 1955.

4. Ridyard, Herbert W., Fetterman, David E., Jr., and Penland, Jim A.: Static Lateral Stability Data From an Exploratory Investigation at a Mach Number of 6.86 of an Airplane Configuration Having a Wing of Trapezoidal Plan Form. NACA RM L55A21a, 1955.

5. Fetterman, David E., Jr., Penland, Jim A., and Ridyard, Herbert W.: Static Longitudinal and Lateral Stability and Control Data From an Exploratory Investigation at a Mach Number of 6.86 of an Airplane Configuration Having a Wing of Trapezoidal Plan Form. NACA RM L55C04, 1955.

6. Ulmann, Edward F., and Lord, Douglas R.: An Investigation of Flow Characteristics at Mach Number 4.04 Over 6- and 9-Percent-Thick Symmetrical Circular-Arc Airfoils Having 30-Percent-Chord Trailing-Edge Flaps. NACA RM L51D30, 1951.

TABLE I.- GEOMETRIC CHARACTERISTICS OF COMPLETE MODEL

Wing:	
Area (including area submerged in fuselage), sq in.	6.24
Span, in.	4.33
Mean aerodynamic chord, in.	1.716
Root chord, in.	2.53
Tip chord, in.	0.354
Airfoil section	Hexagonal with round leading edge
Taper ratio	0.140
Aspect ratio	3.00
Sweep of leading edge, deg	38.83
Sweep of quarter-chord line, deg	29
Incidence at fuselage center line, deg	0
Dihedral, deg	0
Geometric twist, deg	0
Horizontal and vertical tails:	
Area (including area submerged in fuselage), sq in.	2.06
Span, in.	2.69
Mean aerodynamic chord, in.	0.853
Root chord, in.	1.214
Tip chord, in.	0.317
Airfoil section	5° semiangle wedge
Taper ratio	0.261
Aspect ratio	3.52
Sweep of leading edge, deg	22.63
Dihedral, deg	0
Fuselage:	
Length, in.	7.50
Maximum diameter, in.	0.790
Fineness ratio	9.50
Base diameter, in.	0.790
Distance from nose to moment reference	3.950
Ogive nose length, in.	2.29
Ogive radius, in.	6.85

TABLE II

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7×10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(a) $BWT_HT_{VU}T_{VL}$								
4	0	0	0	0.0115	-0.0219	-0.0007	-0.0001	0.0006
			1	.0162	-.0231	-.0117	.0025	.0012
			2	.0151	-.0231	-.0231	.0050	.0012
			3	.0142	-.0230	-.0344	.0075	.0009
			4	.0127	-.0228	-.0460	.0099	0
			5	.0129	-.0230	-.0573	.0122	-.0001
		2	0	.0599	-.0367	.0002	-.0002	.0006
			1	.0673	-.0389	-.0111	.0024	.0010
			2	.0674	-.0387	-.0226	.0050	.0011
			3	.0654	-.0388	-.0336	.0073	.0010
			4	.0656	-.0387	-.0453	.0098	-.0001
			5	.0657	-.0388	-.0564	.0120	.0001
		4	0	.1189	-.0526	.0011	-.0002	.0008
			1	.1205	-.0532	-.0103	.0021	.0007
			2	.1220	-.0533	-.0220	.0047	.0008
2	0	0	0	.0068	-.0106	-.0001	0	.0002
			0	.0094	-.0104	-.0001	-.0001	.0004
			1	.0092	-.0104	-.0107	.0025	-.0005
			1	.0084	-.0103	-.0118	.0025	.0004
			2	.0081	-.0104	-.0225	.0049	-.0005
			2	.0062	-.0098	-.0232	.0051	.0006
			3	.0075	-.0107	-.0344	.0074	-.0005
			3	.0052	-.0100	-.0347	.0075	.0006
			4	.0075	-.0110	-.0456	.0099	-.0004
			4	.0058	-.0105	-.0467	.0100	.0008
			5	.0075	-.0113	-.0574	.0122	-.0002
			5	.0030	-.0104	-.0589	.0123	.0007
		2	0	.0568	-.0252	.0006	-.0001	.0004
			1	.0581	-.0250	-.0103	.0023	0
			2	.0582	-.0251	-.0217	.0049	.0001
			3	.0585	-.0257	-.0336	.0074	-.0001
			4	.0593	-.0259	-.0449	.0097	.0002
			5	.0595	-.0262	-.0566	.0120	0
			5	.0573	-.0259	-.0580	.0121	.0009

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7 × 10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(a) $BWT_HT_{VU}T_{VL}$ - Continued								
2	0	4	0	0.1143	-0.0394	0.0014	-0.0002	0.0003
			1	.1125	-.0386	-.0093	.0021	.0003
			2	.1125	-.0387	-.0216	.0048	.0003
			3	.1127	-.0386	-.0328	.0071	.0001
			4	.1127	-.0388	-.0449	.0097	.0001
		6	0	.1677	-.0530	.0024	-.0002	.0005
			1	.1675	-.0526	-.0091	.0021	.0003
			2	.1678	-.0523	-.0211	.0047	.0004
0	4	0	0	-.0032	.0025	.0174	-.0114	.0002
			0	-.0007	.0011	.0177	-.0118	.0011
			1	-.0027	.0022	.0055	-.0087	.0001
			1	-.0007	.0012	.0060	-.0091	.0010
			2	-.0005	.0016	-.0058	-.0061	.0001
			2	-.0001	.0012	-.0054	-.0064	.0007
			3	-.0016	.0014	-.0176	-.0036	.0001
			3	-.0012	.0011	-.0173	-.0039	.0005
			4	-.0011	.0011	-.0283	-.0014	.0002
			5	-.0016	.0010	-.0401	.0014	.0001
			6	-.0021	.0011	-.0527	.0036	.0000
			7	-.0021	.0012	-.0663	.0062	-.0004
			8	-.0005	.0012	-.0798	.0086	-.0004
		2	1	.0487	-.0120	.0060	-.0089	.0008
			2	.0505	-.0122	-.0053	-.0063	.0008
			3	.0484	-.0118	-.0170	-.0037	.0005
			4	.0515	-.0127	-.0286	-.0012	.0003
			5	.0487	-.0128	-.0416	.0016	.0006
			6	.0511	-.0128	-.0546	.0039	.0002
			7	.0516	-.0130	-.0684	.0066	.0004

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7×10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(a) $BWT_HT_{VU}T_{VL}$ - Continued								
0	4	4	1	0.1050	-0.0247	0.0075	-0.0091	0.0005
			2	-.1054	-.0245	-.0045	.0064	.0005
			3	.1044	-.0245	-.0163	-.0039	.0003
			4	.1043	-.0242	-.0284	-.0014	.0001
			5	.1036	-.0248	-.0414	.0014	.0002
			6	.1058	-.0250	-.0554	.0039	.0004
			7	.1087	-.0254	-.0693	.0066	.0000
		6	2	.1596	-.0376	-.0039	-.0068	.0002
			3	.1588	-.0366	-.0161	-.0042	.0000
			4	.1588	-.0366	-.0293	-.0014	-.0003
			5	.1570	-.0364	-.0426	.0013	.0003
			6	.1618	-.0366	-.0565	.0039	.0003
			7	.1610	-.0364	-.0699	.0067	-.0003
			8	.1609	-.0359	-.0837	.0090	-.0009
		8	4	.2192	-.0497	-.0291	-.0017	-.0006
			5	.2188	-.0497	-.0440	.0014	-.0006
0	2	0	0	-.0033	.0018	.0081	-.0056	.0011
			1	-.0034	.0017	-.0033	-.0029	.0014
			2	-.0023	.0014	-.0146	-.0005	.0013
			3	-.0018	.0011	-.0262	.0018	.0012
			4	-.0029	.0012	-.0380	.0044	.0014
			5	-.0023	.0012	-.0499	.0069	.0013
			6	-.0012	.0013	-.0626	.0093	.0010
			7	-.0012	.0013	-.0764	.0118	.0007
			8	-.0012	.0013	-.0887	.0139	.0006
		2	0	.0513	-.0124	.0093	-.0057	.0003
			1	.0513	-.0125	-.0020	-.0032	.0005
			2	.0514	-.0128	-.0136	-.0004	.0006
			3	.0512	-.0133	-.0249	.0017	.0006
			4	.0515	-.0133	-.0367	.0042	.0005
			5	.0519	-.0134	-.0491	.0066	.0005
			6	.0522	-.0136	-.0619	.0091	.0004
			7	.0526	-.0138	-.0757	.0118	.0008

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7×10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(a) $BWT_HT_{VU}T_{VL}$ - Continued								
0	2	4	0	0.1039	-0.0246	0.0100	-0.0059	-0.0001
			1	.1039	-.0248	-.0015	-.0034	.0000
			2	.1039	-.0247	-.0136	-.0007	.0000
			3	.1044	-.0249	-.0250	.0017	.0000
			4	.1049	-.0250	-.0377	.0042	.0000
			5	.1049	-.0252	-.0495	.0067	.0000
			6	.1054	-.0254	-.0633	.0093	-.0001
			7	.1064	-.0253	-.0771	.0120	-.0001
		6	0	.1553	-.0371	.0109	-.0059	-.0005
			1	.1553	-.0369	-.0010	-.0034	-.0005
			2	.1587	-.0374	-.0130	-.0010	-.0007
			3	.1592	-.0371	-.0255	.0016	-.0005
			4	.1594	-.0371	-.0381	.0042	-.0006
			5	.1589	-.0367	-.0506	.0068	-.0006
			6	.1596	-.0366	-.0635	.0094	-.0005
		8	2	.2157	-.0501	-.0130	-.0011	-.0017
			3	.2148	-.0496	-.0251	.0014	-.0014
			4	.2150	-.0493	-.0379	.0041	-.0012
0	0	Table II (a) ref. 2						
0	-2	0	0	-.0018	.0014	-.0100	.0058	.0011
			1	-.0002	.0011	-.0211	.0084	.0013
			2	-.0002	.0009	-.0325	.0108	.0012
			3	-.0007	.0006	-.0443	.0133	.0013
			3	-.0037	.0013	-.0440	.0133	.0003
		2	0	.0499	-.0127	-.0087	.0058	.0013
			1	.0525	-.0130	-.0197	.0082	.0005
			2	.0527	-.0131	-.0313	.0107	.0006
			3	.0495	-.0131	-.0433	.0132	.0005

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7 × 10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(a) $BWT_HT_{VU}T_{VL}$ - Continued								
0	-2	4	0	0.1050	-0.0258	-0.0078	0.0057	0.0010
			1	.1057	-.0257	-.0188	.0081	.0005
			2	.1053	-.0255	-.0308	.0107	.0005
			3	.1034	-.0255	-.0429	.0130	.0005
		6	0	.1584	-.0387	-.0073	.0057	.0011
			1	.1586	-.0387	-.0187	.0082	.0007
			2	.1585	-.0380	-.0305	.0106	.0005
0	-4	0	0	-.0037	.0019	-.0192	.0120	.0003
		2	0	.0507	-.0125	-.0181	.0120	.0006
		4	0	.1074	-.0261	-.0172	.0119	.0008
-2	0	0	0	-.0065	.0114	-.0006	.0001	.0008
			0	-.0075	.0116	0	0	0
			1	-.0039	.0112	-.0120	.0026	.0015
			1	-.0080	.0116	-.0113	.0025	-.0002
			2	-.0059	.0115	-.0228	.0050	.0003
			2	-.0080	.0117	-.0231	.0050	.0001
			3	-.0080	.0120	-.0340	.0073	.0005
			3	-.0080	.0115	-.0343	.0074	0
			4	-.0106	.0114	-.0472	.0100	.0007
			4	-.0085	.0113	-.0461	.0100	-.0001
			5	-.0085	.0118	-.0576	.0123	.0001
		2	0	.0436	-.0010	.0003	.0001	.0009
			1	.0430	-.0016	-.0112	.0025	.0010
			2	.0428	-.0011	-.0222	.0050	.0007
			3	.0400	-.0006	-.0336	.0072	.0004
			4	.0410	-.0016	-.0464	.0099	.0008
			5	.0435	-.0016	-.0575	.0121	0

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7×10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(a) $BWT_HT_{VU}T_{VL}$ - Continued								
-2	0	4	0	0.0979	-0.0131	0.0009	0	0.0011
			1	.0958	-.0132	-.0099	.0023	.0011
			2	.0974	-.0131	-.0217	.0050	.0006
			3	.0964	-.0126	-.0327	.0070	.0004
			4	.0968	-.0134	-.0463	.0099	.0010
			5	.0979	-.0133	-.0573	.0123	.0005
		6	0	.1518	-.0257	.0018	-.0001	.0010
			1	.1491	-.0257	-.0095	.0023	.0009
			2	.1507	-.0254	-.0219	.0048	.0004
			3	.1501	-.0241	-.0327	.0070	.0004
			4	.1507	-.0250	-.0474	.0100	.0010
			5	.1496	-.0241	-.0592	.0125	.0005
		8	0	.2078	-.0381	.0035	-.0002	.0005
			1	.2085	-.0394	-.0090	.0024	.0009
			2	.2083	-.0383	-.0219	.0050	.0006
			3	.2062	-.0372	-.0331	.0071	0
-4	0	0	0	-.0138	.0240	-.0007	0	.0010
			1	-.0101	.0229	-.0120	.0026	.0009
			2	-.0128	.0238	-.0234	.0051	.0011
			3	-.0149	.0248	-.0347	.0076	.0009
			4	-.0160	.0252	-.0467	.0100	.0009
			5	-.0160	.0264	-.0579	.0123	.0010
		2	0	.0330	.0117	-.0003	-.0001	.0011
			1	.0365	.0114	-.0108	.0024	.0006
			2	.0365	.0112	-.0226	.0050	.0005
			3	.0359	.0114	-.0339	.0074	.0006
			4	.0348	.0120	-.0456	.0099	.0008
			5	.0348	.0123	-.0574	.0122	.0008

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7×10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(a) $BWT_HT_{VU}T_{VL}$ - Continued								
-4	0	4	0	0.0888	-0.0005	0.0007	-0.0001	0.0014
			1	.0894	-.0003	-.0099	.0022	.0003
			2	.0896	-.0004	-.0219	.0049	.0004
			3	.0899	-.0001	-.0332	.0073	.0002
			4	.0876	.0004	-.0454	.0098	.0003
			5	.0878	.0006	-.0569	.0121	.0003
		6	0	.1415	-.0123	.0017	-.0001	.0016
			1	.1422	-.0125	-.0097	.0023	.0004
			2	.1416	-.0123	-.0223	.0048	.0006
			3	.1410	-.0114	-.0344	.0073	.0010
			4	.1412	-.0109	-.0473	.0100	.0010
			5	.1417	-.0104	-.0597	.0124	.0013
		8	0	.1986	-.0260	.0027	-.0002	.0014
			1	.1994	-.0259	-.0090	.0023	-.0001
			2	.1994	-.0253	-.0224	.0051	.0002
			3	.2001	-.0250	-.0348	.0075	.0006
			4	.2006	-.0245	-.0479	.0102	.0008
			5	.2008	-.0240	-.0609	.0128	.0011
		10	0	.2693	-.0455	.0038	-.0002	.0017
			1	.2669	-.0445	-.0101	.0026	.0002
-6	0	0	0	-.0237	.0380	-.0010	0	.0006
			1	-.0180	.0365	-.0113	.0027	.0003
			1	-.0209	.0372	-.0113	.0025	.0003
			2	-.0206	.0372	-.0226	.0051	-.0001
			2	-.0214	.0374	-.0231	.0051	.0002
			3	-.0207	.0373	-.0338	.0076	-.0002
			3	-.0223	.0374	-.0344	.0075	.0003
			4	-.0207	.0378	-.0453	.0100	-.0003
			4	-.0227	.0374	-.0462	.0100	.0003
			5	-.0213	.0382	-.0567	.0123	-.0005
			5	-.0209	.0375	-.0579	.0123	.0003
			6	-.0211	.0376	-.0659	.0133	-.0008

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7×10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(a) $BWT_HT_{VU}T_{VL}$ - Continued								
-6	0	2	0	0.0240	0.0245	-0.0002	0.0001	0.0008
			1	.0272	.0240	-.0115	.0026	.0003
			2	.0268	.0248	-.0228	.0052	.0002
			3	.0269	.0248	-.0342	.0076	.0001
			4	.0287	.0248	-.0448	.0097	-.0004
			5	.0253	.0250	-.0576	.0123	.0005
		4	0	.0793	.0132	.0007	0	.0008
			1	.0803	.0127	-.0103	.0024	.0005
			2	.0811	.0132	-.0224	.0051	.0004
			3	.0806	.0137	-.0336	.0074	.0002
			4	.0806	.0143	-.0446	.0097	.0001
			5	.0786	.0140	-.0577	.0123	.0009
		6	0	.1325	.0017	.0016	-.0001	.0007
			1	.1329	.0010	-.0101	.0024	.0004
			2	.1352	.0017	-.0221	.0049	.0003
			3	.1339	.0027	-.0335	.0074	.0001
			4	.1330	.0036	-.0462	.0098	-.0002
			5	.1318	.0036	-.0593	.0125	.0009
		8	0	.1868	-.0121	.0027	-.0002	.0007
			1	.1876	-.0124	-.0096	.0025	.0005
			2	.1905	-.0118	-.0226	.0052	.0005
			3	.1898	-.0110	-.0342	.0076	0
			4	.1937	-.0110	-.0468	.0101	.0001
			5	.1908	-.0107	-.0610	.0129	.0012
		10	0	.2588	-.0320	.0039	-.0003	.0002
			1	.2561	-.0316	-.0106	.0028	-.0002
			2	.2589	-.0309	-.0232	.0053	.0003
			3	.2608	-.0306	-.0352	.0076	-.0001

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7×10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(a) $BWT_HT_{VU}T_{VL}$ - Continued								
-8	0	0	0	-0.0332	0.0514	-0.0011	0.0001	0.0003
			1	-.0316	.0513	-.0122	.0026	-.0001
			2	-.0279	.0503	-.0236	.0052	-.0002
			3	-.0290	.0508	-.0350	.0076	-.0002
			3	-.0330	.0509	-.0353	.0078	.0012
			4	-.0290	.0513	-.0468	.0102	-.0005
			5	-.0279	.0486	-.0559	.0114	-.0008
			6	-.0259	.0453	-.0641	.0118	-.0007
		2	0	.0184	.0368	-.0005	.0002	.0001
			1	.0168	.0371	-.0114	.0026	.0003
			2	.0188	.0377	-.0227	.0051	-.0001
			3	.0161	.0373	-.0349	.0077	.0012
			4	.0178	.0384	-.0464	.0101	.0008
			5	.0168	.0390	-.0575	.0124	.0006
		4	0	.0721	.0264	.0007	0	.0002
			1	.0720	.0259	-.0105	.0025	.0002
			2	.0721	.0268	-.0223	.0051	-.0002
			3	.0692	.0268	-.0344	.0075	.0016
			4	.0722	.0279	-.0465	.0100	.0012
			5	.0724	.0281	-.0579	.0124	.0010
		6	0	.1247	.0147	.0013	0	.0001
			1	.1253	.0144	-.0103	.0024	.0002
			2	.1261	.0155	-.0219	.0050	-.0002
			3	.1231	.0159	-.0348	.0075	.0017
			4	.1254	.0171	-.0472	.0101	.0014
			5	.1238	.0182	-.0586	.0126	.0012
		8	0	.1869	-.0021	.0024	0	0
			1	.1808	-.0003	-.0095	.0025	.0001
			2	.1831	.0008	-.0222	.0052	.0002
			3	.1811	.0012	-.0354	.0077	.0017
			4	.1840	.0022	-.0485	.0103	.0014
			5	.1837	.0033	-.0607	.0130	.0014

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; $M = 4.06$; $R = 2.7 \times 10^6$]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(a) $BWT_HT_{VU}T_{VL}$ - Concluded								
-8	0	10	0	0.2532	-0.0206	0.0035	-0.0001	-0.0001
			1	.2519	-.0200	-.0107	.0028	.0001
			2	.2530	-.0194	-.0226	.0053	-.0003
			3	.2522	-.0185	-.0363	.0078	.0020
			4	.2521	-.0172	-.0502	.0107	.0017
		12	0	.3185	-.0352	.0052	-.0003	-.0001
			1	.3162	-.0349	-.0099	.0028	-.0001
			2	.3177	-.0342	-.0232	.0053	-.0001
(b) BWT_HT_{VU}								
0	6	0	0	-.0041	.0081	.0129	-.0088	.0027
			1	-.0035	.0079	.0049	-.0082	.0019
			2	-.0034	.0076	-.0033	-.0077	.0012
			3	-.0061	.0080	-.0115	-.0073	.0002
			4	-.0065	.0081	-.0209	-.0069	.0010
			6	-.0063	.0082	-.0399	-.0053	-.0003
			8	-.0061	.0085	-.0620	-.0034	-.0013
		2	0	.0479	-.0051	.0126	-.0080	.0025
			1	.0466	-.0040	.0048	-.0078	.0016
			2	.0480	-.0052	-.0032	-.0076	.0005
			3	.0462	-.0040	-.0107	-.0073	-.0003
			4	.0462	-.0054	-.0203	-.0071	.0006
			6	.0465	-.0047	-.0385	-.0059	-.0009
			8	.0478	-.0046	-.0611	-.0040	-.0019
		4	0	.1027	-.0177	.0126	-.0074	.0021
			1	.1020	-.0174	.0051	-.0075	.0012
			2	.1020	-.0173	-.0029	-.0075	.0005
			3	.1004	-.0167	-.0105	-.0074	-.0007
			4	.0993	-.0165	-.0194	-.0074	.0001
			6	.1008	-.0162	-.0382	-.0064	-.0010
			8	.1022	-.0152	-.0607	-.0045	-.0025

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7 × 10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(b) BWT_HT_{VU} - Continued								
0	6	6	0	0.1553	-0.0303	0.0127	-0.0069	0.0016
			1	.1572	-.0303	.0052	-.0071	.0010
			2	.1556	-.0295	-.0025	-.0074	-.0002
			3	.1543	-.0286	-.0107	-.0075	-.0012
			4	.1540	-.0283	-.0201	-.0076	.0000
			6	.1537	-.0265	-.0391	-.0067	-.0018
			8	.1554	-.0255	-.0612	-.0049	-.0037
		8	6	.2112	-.0383	-.0404	-.0068	-.0023
			8	.2115	-.0363	-.0626	-.0053	-.0039
0	4	0	0	-.0009	.0066	.0080	-.0058	.0024
			1	-.0029	.0069	.0002	-.0052	.0016
			2	-.0034	.0071	-.0077	-.0048	.0011
			3	-.0088	.0087	-.0159	-.0044	.0000
			4	-.0041	.0072	-.0251	-.0040	-.0006
			6	-.0066	.0085	-.0440	-.0025	-.0016
			8	-.0065	.0091	-.0668	-.0005	-.0026
		2	0	.0453	-.0041	.0080	-.0053	.0022
			1	.0474	-.0042	.0007	-.0051	.0012
			2	.0476	-.0042	-.0069	-.0049	.0005
			3	.0452	-.0044	-.0147	-.0047	-.0004
			4	.0465	-.0041	-.0243	-.0045	-.0010
			6	.0495	-.0038	-.0428	-.0035	-.0020
			8	.0497	-.0034	-.0656	-.0015	-.0033
		4	0	.1038	-.0180	.0085	-.0050	.0018
			1	.1019	-.0174	.0015	-.0050	.0012
			2	.1012	-.0174	-.0062	-.0051	.0006
			3	.0997	-.0173	-.0143	-.0050	-.0006
			4	.1020	-.0164	-.0229	-.0050	-.0010
			6	.1035	-.0164	-.0425	-.0041	-.0020
			8	.1060	-.0153	-.0646	-.0023	-.0038

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7 × 10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(b) BWT_HT_{VU} - Continued								
0	4	6	0	0.1588	-0.0310	0.0092	-0.0046	0.0017
			1	.1556	-.0301	.0014	-.0049	.0008
			2	.1559	-.0297	-.0057	-.0052	-.0001
			3	.1538	-.0284	-.0142	-.0054	-.0011
			4	.1565	-.0287	-.0235	-.0054	-.0016
			6	.1563	-.0269	-.0425	-.0046	-.0028
			8	.1581	-.0257	-.0650	-.0029	-.0043
		8	2	.2117	-.0416	-.0069	-.0053	-.0008
			3	.2114	-.0410	-.0161	-.0056	-.0014
			4	.2135	-.0407	-.0241	-.0056	-.0018
			6	.2145	-.0389	-.0436	-.0049	-.0028
			8	.2159	-.0367	-.0655	-.0034	-.0048
0	2	0	0	-.0038	.0073	.0036	-.0029	.0010
			1	-.0038	.0073	-.0043	-.0024	.0005
			2	-.0042	.0073	-.0123	-.0021	-.0002
			3	-.0063	.0081	-.0139	-.0017	-.0003
			4	-.0061	.0082	-.0293	-.0013	-.0011
			5	-.0066	.0085	-.0384	-.0006	-.0016
			6	-.0070	.0089	-.0486	.0001	-.0022
			7	-.0064	.0094	-.0599	.0011	-.0028
			7	-.0049	.0087	-.0597	.0008	-.0024
			8	-.0058	.0096	-.0709	.0021	-.0034
			8	-.0048	.0090	-.0710	.0020	-.0028
		2	0	.0496	-.0057	.0046	-.0027	.0005
			1	.0451	-.0034	-.0032	-.0026	.0007
			2	.0474	-.0040	-.0108	-.0024	.0001
			3	.0476	-.0040	-.0190	-.0023	-.0006
			4	.0468	-.0038	-.0267	-.0020	-.0014
			5	.0466	-.0038	-.0361	-.0016	-.0020
			6	.0467	-.0041	-.0467	-.0010	-.0022
			7	.0485	-.0038	-.0574	-.0002	-.0028
			8	.0508	-.0043	-.0688	.0007	-.0033

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7×10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(b) BWT_HT_{VU} - Continued								
0	2	4	0	0.1016	-0.0175	0.0053	-0.0025	0.0002
			1	.1002	-.0173	-.0024	-.0027	.0004
			2	.1023	-.0176	-.0101	-.0028	-.0002
			3	.1005	-.0168	-.0177	-.0028	-.0008
			4	.1006	-.0164	-.0259	-.0027	-.0016
			5	.1014	-.0159	-.0348	-.0024	-.0024
			6	.1004	-.0157	-.0458	-.0018	-.0024
			7	.1028	-.0150	-.0563	-.0012	-.0029
			8	.1040	-.0147	-.0678	-.0001	-.0036
		6	0	.1577	-.0307	.0058	-.0024	-.0004
			1	.1555	-.0302	-.0016	-.0027	.0000
			2	.1550	-.0295	-.0091	-.0030	-.0007
			3	.1560	-.0291	-.0175	-.0033	-.0015
			4	.1545	-.0279	-.0260	-.0033	-.0020
			5	.1545	-.0273	-.0343	-.0030	-.0027
			6	.1558	-.0264	-.0456	-.0026	-.0029
			7	.1545	-.0256	-.0561	-.0019	-.0034
			8	.1557	-.0252	-.0672	-.0010	-.0041
		8	0	.2155	-.0448	.0069	-.0022	-.0008
			1	.2119	-.0427	-.0009	-.0027	.0001
			2	.2118	-.0417	-.0097	-.0033	-.0007
			3	.2109	-.0407	-.0172	-.0036	-.0014
			4	.2114	-.0399	-.0260	-.0037	-.0022
			5	.2124	-.0392	-.0350	-.0035	-.0030
			6	.2127	-.0382	-.0463	-.0030	-.0031
			7	.2110	-.0364	-.0571	-.0024	-.0037
			8	.2134	-.0358	-.0682	-.0016	-.0048

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7×10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(b) BWT_HT_{VU} - Continued								
0	0	0	0	-0.0016	0.0063	-0.0009	0.0000	-0.0001
			1	-.0052	.0073	-.0088	.0004	-.0006
			2	-.0051	.0075	-.0170	.0008	-.0010
			3	-.0056	.0077	-.0253	.0012	-.0014
			4	-.0065	.0081	-.0337	.0017	-.0019
			5	-.0075	.0085	-.0428	.0023	-.0025
			6	-.0069	.0092	-.0534	.0031	-.0033
			7	-.0062	.0097	-.0649	.0040	-.0039
			8	-.0062	.0102	-.0760	.0051	-.0043
		2	0	.0488	-.0056	.0003	.0000	-.0008
			1	.0486	-.0057	-.0072	.0001	-.0011
			2	.0476	-.0057	-.0149	.0003	-.0016
			3	.0476	-.0058	-.0231	.0004	-.0022
			4	.0477	-.0056	-.0313	.0006	-.0027
			5	.0477	-.0051	-.0402	.0011	-.0032
			6	.0477	-.0038	-.0504	.0016	-.0038
			7	.0483	-.0037	-.0619	.0026	-.0043
			8	.0489	-.0034	-.0733	.0036	-.0047
		4	0	.1023	-.0181	.0013	.0000	.0012
			1	.1018	-.0181	-.0062	-.0003	.0007
			2	.1007	-.0178	-.0140	-.0003	-.0001
			3	.1008	-.0174	-.0218	-.0003	-.0005
			4	.1019	-.0170	-.0301	-.0003	-.0009
			5	.1020	-.0166	-.0393	.0001	-.0015
			6	.1005	-.0158	-.0497	.0006	-.0020
			7	.1017	-.0149	-.0611	.0014	-.0029
			8	.1022	-.0141	-.0722	.0023	-.0037

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7 × 10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(b) BWT_HT_{VU} - Continued								
0	0	6	0	0.1580	-0.0314	0.0022	-0.0001	0.0004
			1	.1582	-.0311	-.0051	-.0005	-.0003
			2	.1579	-.0305	-.0126	-.0008	-.0007
			3	.1559	-.0292	-.0207	-.0010	-.0013
			4	.1562	-.0287	-.0293	-.0010	-.0017
			5	.1549	-.0273	-.0383	-.0008	-.0024
			6	.1563	-.0263	-.0483	-.0004	-.0031
			7	.1570	-.0257	-.0591	.0003	-.0044
			8	.1580	-.0245	-.0700	.0011	-.0051
		8	0	.2104	-.0424	.0037	-.0001	-.0003
			1	.2107	-.0421	-.0035	-.0006	-.0008
			2	.2103	-.0414	-.0120	-.0013	-.0013
			3	.2097	-.0403	-.0199	-.0017	-.0020
			4	.2108	-.0396	-.0282	-.0019	-.0024
			5	.2121	-.0387	-.0372	-.0017	-.0028
			6	.2108	-.0375	-.0483	-.0012	-.0035
			7	.2124	-.0364	-.0596	-.0005	-.0041
			8	.2144	-.0355	-.0710	.0002	-.0049
0	-2	0	0	-.0037	.0071	-.0051	.0029	.0002
			1	-.0036	.0072	-.0132	.0033	-.0003
			2	-.0046	.0077	-.0217	.0037	-.0008
			3	-.0061	.0082	-.0298	.0041	-.0014
			4	-.0060	.0084	-.0382	.0046	-.0019
			5	-.0059	.0088	-.0473	.0051	-.0025
			6	-.0058	.0095	-.0577	.0059	-.0033
			7	-.0063	.0104	-.0688	.0069	-.0037
			8	-.0062	.0126	-.0805	.0081	-.0043

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7×10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(b) BWT_HT_{VU} - Continued								
0	-2	2	0	0.0474	-0.0054	-0.0035	0.0026	-0.0002
			1	.0475	-.0054	-.0122	.0028	-.0011
			2	.0475	-.0054	-.0192	.0029	-.0017
			3	.0469	-.0054	-.0272	.0030	-.0020
			4	.0469	-.0046	-.0358	.0033	-.0025
			5	.0470	-.0044	-.0445	.0037	-.0031
			6	.0475	-.0036	-.0546	.0042	-.0037
			7	.0481	-.0034	-.0655	.0051	-.0041
			8	.0482	-.0028	-.0768	.0062	-.0045
		4	0	.1013	-.0179	-.0024	.0024	-.0003
			1	.1022	-.0178	-.0095	.0022	-.0012
			2	.1017	-.0175	-.0173	.0022	-.0018
			3	.1019	-.0169	-.0251	.0021	-.0026
			4	.1010	-.0163	-.0335	.0022	-.0030
			5	.1003	-.0154	-.0427	.0025	-.0034
			6	.1010	-.0146	-.0533	.0030	-.0040
			7	.1017	-.0137	-.0640	.0037	-.0046
			8	.1025	-.0127	-.0755	.0047	-.0053
		6	0	.1559	-.0304	-.0010	.0021	-.0005
			1	.1557	-.0300	-.0084	.0018	-.0008
			2	.1553	-.0295	-.0160	.0014	-.0016
			3	.1552	-.0286	-.0243	.0012	-.0024
			4	.1554	-.0279	-.0333	.0011	-.0036
			5	.1545	-.0266	-.0418	.0014	-.0042
			6	.1551	-.0257	-.0522	.0018	-.0048
			7	.1557	-.0252	-.0629	.0025	-.0053
			8	.1563	-.0234	-.0742	.0034	-.0057
		8	0	.2108	-.0425	.0002	.0019	-.0005
			1	.2134	-.0426	-.0071	.0015	-.0014
			2	.2130	-.0417	-.0153	.0009	-.0021
			3	.2121	-.0410	-.0238	.0001	-.0026
			4	.2122	-.0399	-.0321	.0004	-.0032
			5	.2129	-.0390	-.0416	.0006	-.0038
			6	.2138	-.0381	-.0524	.0010	-.0046
			7	.2113	-.0361	-.0629	.0017	-.0054
			8	.2114	-.0348	-.0748	.0024	-.0060

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7×10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(b) BWT_HT_{VU} - Continued								
0	-4	0	0	-0.0046	0.0077	-0.0097	0.0058	-0.0006
			1	-.0056	.0082	-.0179	.0063	-.0014
			2	-.0055	.0085	-.0259	.0066	-.0021
			3	-.0054	.0086	-.0340	.0069	-.0034
			4	-.0053	.0079	-.0421	.0074	-.0038
			6	-.0077	.0126	-.0625	.0089	-.0043
			8	-.0060	.0133	-.0853	.0110	-.0055
		2	0	.0460	-.0043	-.0085	.0052	-.0007
			1	.0473	-.0044	-.0158	.0053	-.0011
			2	.0486	-.0047	-.0238	.0055	-.0020
			3	.0462	-.0043	-.0311	.0058	-.0033
			4	.0460	-.0042	-.0404	.0059	-.0039
			6	.0459	-.0028	-.0597	.0069	-.0042
			8	.0484	-.0013	-.0810	.0087	-.0056
		4	0	.1014	-.0177	-.0063	.0048	-.0007
			1	.1028	-.0177	-.0134	.0046	-.0009
			2	.1017	-.0174	-.0220	.0046	-.0022
			3	.1017	-.0164	-.0287	.0046	-.0035
			4	.1010	-.0156	-.0372	.0046	-.0045
			6	.1018	-.0148	-.0577	.0054	-.0045
			8	.1019	-.0121	-.0796	.0071	-.0062
		6	0	.1579	-.0309	-.0050	.0043	-.0006
			1	.1568	-.0303	-.0124	.0041	-.0011
			2	.1575	-.0298	-.0201	.0037	-.0030
			3	.1554	-.0283	-.0272	.0035	-.0035
			4	.1545	-.0271	-.0360	.0033	-.0044
			6	.1552	-.0257	-.0563	.0041	-.0049
			8	.1548	-.0234	-.0777	.0057	-.0061
		8	0	.2123	-.0449	-.0036	.0040	-.0008
			1	.2098	-.0421	-.0113	.0037	-.0014
			2	.2148	-.0421	-.0189	.0030	-.0024
			3	.2120	-.0403	-.0266	.0025	-.0033
			4	.2137	-.0394	-.0345	.0020	-.0044
			6	.2142	-.0377	-.0562	.0030	-.0045
			8	.2137	-.0346	-.0783	.0044	-.0061

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7×10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(b) BWT_HT_{VU} - Continued								
0	-6	0	0	-0.0050	0.0081	-0.0142	0.0088	-0.0016
			1	-.0049	.0085	-.0224	.0092	-.0025
			2	-.0048	.0090	-.0303	.0097	-.0030
			3	-.0040	.0094	-.0387	.0101	-.0042
			4	-.0067	.0101	-.0481	.0107	-.0043
			6	-.0075	.0130	-.0669	.0119	-.0059
			8	-.0063	.0129	-.0874	.0133	-.0069
		2	0	.0471	-.0051	-.0123	.0080	-.0014
			1	.0490	-.0050	-.0191	.0081	-.0020
			2	.0466	-.0043	-.0277	.0084	-.0031
			3	.0451	-.0035	-.0356	.0086	-.0040
			4	.0454	-.0032	-.0451	.0089	-.0044
			6	.0474	-.0019	-.0634	.0097	-.0059
			8	.0467	-.0003	-.0854	.0117	-.0071
		4	0	.1019	-.0178	-.0104	.0073	-.0012
			1	.1015	-.0171	-.0179	.0072	-.0024
			2	.1034	-.0175	-.0257	.0072	-.0035
			3	.1010	-.0158	-.0333	.0073	-.0043
			4	.1002	-.0150	-.0424	.0074	-.0047
			6	.1017	-.0134	-.0611	.0081	-.0055
			8	.1014	-.0113	-.0825	.0097	-.0073
		6	0	.1551	-.0304	-.0088	.0067	-.0012
			1	.1547	-.0296	-.0161	.0065	-.0026
			2	.1570	-.0292	-.0241	.0061	-.0033
			3	.1546	-.0276	-.0313	.0059	-.0040
			4	.1544	-.0266	-.0409	.0059	-.0043
			6	.1554	-.0253	-.0598	.0066	-.0059
			8	.1547	-.0225	-.0802	.0079	-.0071

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7×10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(b) BWT_HT_{VU} - Concluded								
0	-6	8	0	0.2157	-0.0451	-0.0066	0.0063	-0.0010
			1	.2132	-.0426	-.0141	.0058	-.0016
			2	.2117	-.0411	-.0223	.0052	-.0034
			3	.2111	-.0400	-.0295	.0047	-.0041
			4	.2097	-.0382	-.0391	.0046	-.0044
			6	.2128	-.0361	-.0586	.0052	-.0059
↓	↓	↓	8	.2135	-.0334	-.0806	.0064	-.0074
(c) BWT_HT_{VL}								
0	6	0	0	.0050	-.0068	.0139	-.0093	-.0019
			1	.0016	-.0052	.0051	-.0086	-.0036
			1	.0049	-.0064	.0055	-.0088	-.0010
			2	.0039	-.0048	-.0029	-.0080	-.0013
			3	.0028	-.0054	-.0112	-.0076	-.0006
			4	.0031	-.0050	-.0202	-.0072	.0007
			6	.0046	-.0061	-.0380	-.0059	.0009
		↓	8	.0051	-.0064	-.0603	-.0040	.0015
		2	0	.0540	-.0206	.0152	-.0101	-.0021
			1	.0543	-.0196	.0068	-.0093	-.0019
			1	.0530	-.0195	.0067	-.0094	-.0010
			2	.0532	-.0188	-.0019	-.0086	-.0015
			3	.0512	-.0184	-.0100	-.0079	-.0015
			4	.0560	-.0198	-.0194	-.0074	.0000
			6	.0557	-.0191	-.0385	-.0058	.0003
		↓	8	.0565	-.0187	-.0605	-.0038	.0007
		4	1	.1068	-.0320	.0091	-.0100	-.0012
			2	.1086	-.0316	-.0004	-.0090	-.0023
			3	.1055	-.0306	-.0095	-.0081	-.0022
			4	.1072	-.0307	-.0193	-.0074	-.0004
			6	.1092	-.0306	-.0397	-.0054	-.0001
↓	↓	↓	8	.1106	-.0295	-.0619	-.0033	-.0001

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7×10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(c) BWT_HT_{VL} - Continued								
0	6	6	4	0.1612	-0.0425	-0.0202	-0.0075	-0.0010
			6	.1611	-.0411	-.0409	-.0053	-.0008
			8	.1625	-.0394	-.0631	-.0029	-.0007
0	4	0	0	.0034	-.0062	.0090	-.0061	-.0012
			1	.0044	-.0060	.0010	-.0056	-.0008
			2	.0043	-.0060	-.0071	-.0050	-.0003
			3	.0033	-.0055	-.0154	-.0047	-.0002
			4	.0034	-.0064	-.0246	-.0043	.0016
			6	.0018	-.0064	-.0437	-.0029	.0022
			8	.0021	-.0070	-.0659	-.0009	.0032
		2	0	.0513	-.0190	.0101	-.0066	-.0014
			1	.0526	-.0189	.0021	-.0060	-.0008
			2	.0520	-.0187	-.0066	-.0053	-.0006
			3	.0517	-.0186	-.0149	-.0047	-.0005
			4	.0511	-.0192	-.0244	-.0041	.0011
			6	.0552	-.0197	-.0443	-.0025	.0018
			8	.0552	-.0198	-.0670	-.0005	.0026
		4	0	.1076	-.0318	.0122	-.0071	-.0018
			1	.1060	-.0313	.0018	-.0062	-.0016
			1	.1060	-.0313	.0029	-.0062	-.0016
			2	.1084	-.0315	-.0061	-.0055	-.0012
			3	.1067	-.0313	-.0145	-.0046	-.0008
			4	.1071	-.0315	-.0246	-.0038	.0007
			6	.1082	-.0315	-.0461	-.0018	.0015
			8	.1104	-.0320	-.0691	.0005	.0020
		6	2	.1615	-.0437	-.0052	-.0058	-.0018
			3	.1613	-.0429	-.0151	-.0047	-.0020
			4	.1605	-.0427	-.0259	-.0036	.0003
			6	.1623	-.0427	-.0477	-.0013	.0006
			8	.1626	-.0422	-.0715	.0013	.0014

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7 × 10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(c) BWT_HT_{VL} - Continued								
0	2	0	0	0.0010	-0.0050	0.0041	-0.0032	0.0005
			1	.0025	-.0054	-.0037	-.0028	.0011
			2	.0024	-.0054	-.0122	-.0023	.0016
			3	.0008	-.0053	-.0198	-.0021	.0016
			4	.0007	-.0058	-.0279	-.0017	.0021
			4	.0019	-.0066	-.0283	-.0016	.0015
			6	.0001	-.0062	-.0458	-.0006	.0028
			6	.0028	-.0073	-.0475	-.0003	.0026
			8	.0021	-.0077	-.0703	.0016	.0037
		2	0	.0473	-.0178	.0052	-.0035	.0004
			1	.0542	-.0194	-.0029	-.0028	.0010
			2	.0522	-.0189	-.0114	-.0023	.0012
			3	.0518	-.0190	-.0199	-.0018	.0015
			4	.0540	-.0195	-.0281	-.0013	.0017
			6	.0536	-.0195	-.0471	.0002	.0022
			8	.0556	-.0208	-.0716	.0025	.0031
		4	0	.1064	-.0313	.0068	-.0038	0
			1	.1059	-.0314	-.0022	-.0030	.0008
			2	.1072	-.0315	-.0108	-.0023	.0010
			3	.1080	-.0315	-.0202	-.0015	.0012
			4	.1075	-.0314	-.0289	-.0008	.0015
			6	.1063	-.0307	-.0491	.0011	.0020
			8	.1107	-.0324	-.0737	.0038	.0025
		6	0	.1612	-.0440	.0083	-.0042	-.0001
			1	.1588	-.0434	-.0013	-.0032	-.0003
			2	.1601	-.0435	-.0110	-.0023	.0007
			3	.1608	-.0434	-.0207	-.0013	.0010
			4	.1602	-.0422	-.0306	-.0004	.0005
			6	.1608	-.0418	-.0511	.0018	.0017
			8	.1638	-.0433	-.0765	.0049	.0024

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7×10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(c) BWT_HT_{VL} - Continued								
0	0	0	0	0.0026	-0.0054	-0.0003	-0.0004	0.0005
			0	.0021	-.0051	.0002	-.0004	.0001
			1	.0046	-.0059	-.0082	.0001	.0012
			1	.0021	-.0054	-.0076	-.0001	.0007
			2	.0050	-.0060	-.0163	.0004	.0017
			2	.0025	-.0060	-.0161	.0004	.0014
			3	.0019	-.0060	-.0240	.0007	.0014
			3	.0023	-.0066	-.0245	.0007	.0021
			4	.0018	-.0066	-.0319	.0011	.0019
			4	.0022	-.0072	-.0324	.0011	.0027
			5	.0022	-.0076	-.0418	.0017	.0032
			6	.0029	-.0069	-.0502	.0023	.0024
			6	.0021	-.0080	-.0518	.0024	.0033
			7	.0025	-.0084	-.0633	.0033	.0041
			8	.0014	-.0088	-.0749	.0044	.0047
		2	0	.0527	-.0189	.0005	-.0004	.0004
			1	.0538	-.0191	-.0075	.0002	.0012
			2	.0559	-.0196	-.0163	.0007	.0014
			3	.0539	-.0193	-.0240	.0012	.0014
			4	.0525	-.0194	-.0325	.0018	.0016
			6	.0540	-.0192	-.0517	.0034	.0019
			8	.0561	-.0218	-.0768	.0056	.0043
		4	0	.1061	-.0317	.0014	-.0004	.0003
			1	.1073	-.0315	-.0072	.0003	.0010
			2	.1078	-.0312	-.0163	.0009	.0013
			3	.1070	-.0310	-.0246	.0016	.0014
			4	.1057	-.0305	-.0335	.0025	.0014
			6	.1099	-.0303	-.0546	.0047	.0019
			8	.1113	-.0331	-.0796	.0073	.0039

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7 × 10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(c) BWT_HT_{VL} - Continued								
0	0	6	0	0.1610	-0.0439	0.0024	-0.0005	0.0003
			1	.1617	-.0443	-.0074	.0004	.0007
			2	.1638	-.0440	-.0164	.0011	.0007
			3	.1590	-.0427	-.0259	.0021	.0009
			4	.1630	-.0422	-.0361	.0033	.0009
↓	↓	↓	6	.1607	-.0408	-.0564	.0056	.0036
0	-2	0	0	.0023	-.0059	-.0051	.0026	.0019
			1	.0022	-.0058	-.0127	.0030	.0026
			2	.0027	-.0063	-.0209	.0034	.0031
			3	.0022	-.0072	-.0291	.0038	.0030
			4	.0010	-.0073	-.0373	.0041	.0038
			6	.0015	-.0081	-.0547	.0050	.0041
		↓	8	.0018	-.0099	-.0795	.0074	.0055
		2	0	.0502	-.0186	-.0042	.0029	.0017
			1	.0550	-.0198	-.0132	.0035	.0024
			2	.0544	-.0200	-.0209	.0041	.0029
			3	.0535	-.0201	-.0296	.0047	.0029
			4	.0535	-.0206	-.0382	.0051	.0033
			6	.0530	-.0210	-.0583	.0064	.0039
		↓	8	.0564	-.0234	-.0817	.0090	.0052
		4	0	.1076	-.0318	-.0038	.0028	.0016
			1	.1067	-.0318	-.0131	.0037	.0024
			2	.1066	-.0319	-.0217	.0046	.0028
			3	.1090	-.0324	-.0307	.0054	.0030
			4	.1073	-.0323	-.0400	.0061	.0033
			6	.1095	-.0329	-.0602	.0080	.0022
		↓	8	.1101	-.0347	-.0858	.0110	.0053
		6	0	.1575	-.0435	-.0038	.0034	.0017
			1	.1603	-.0442	-.0141	.0042	.0020
			2	.1636	-.0445	-.0222	.0051	.0024
			3	.1623	-.0553	-.0319	.0060	.0023
↓	↓	↓	4	.1617	-.0439	-.0426	.0071	.0031

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; $M = 4.06$; $R = 2.7 \times 10^6$]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(c) BWT_HT_{VL} - Continued								
0	-4	0	0	0.0022	-0.0076	-0.0093	0.0055	0.0028
			1	.0037	-.0085	-.0172	.0060	.0034
			2	.0015	-.0081	-.0256	.0064	.0040
			3	.0004	-.0085	-.0329	.0067	.0041
			4	.0003	-.0092	-.0417	.0071	.0045
			6	.0029	-.0101	-.0610	.0083	.0050
			7	.0035	-.0100	-.0715	.0091	.0054
			8	.0035	-.0106	-.0827	.0103	.0054
		2	0	.0500	-.0200	-.0091	.0060	.0026
			1	.0539	-.0212	-.0180	.0067	.0033
			2	.0539	-.0223	-.0261	.0072	.0037
			3	.0540	-.0221	-.0347	.0079	.0038
			4	.0536	-.0226	-.0436	.0086	.0045
			6	.0547	-.0228	-.0634	.0099	.0051
			7	.0557	-.0236	-.0746	.0111	.0053
			8	.0559	-.0241	-.0850	.0123	.0057
		4	0	.1075	-.0332	-.0090	.0065	.0027
			1	.1072	-.0334	-.0179	.0072	.0034
			2	.1063	-.0335	-.0267	.0080	.0036
			3	.1069	-.0337	-.0366	.0088	.0040
			4	.1081	-.0342	-.0453	.0096	.0041
			6	.1094	-.0345	-.0667	.0117	.0048
		6	0	.1605	-.0456	-.0092	.0070	.0026
			1	.1614	-.0461	-.0188	.0079	.0036
			2	.1629	-.0462	-.0278	.0089	.0035
0	-6	0	0	.0016	-.0055	-.0140	.0086	.0029
			1	.0053	-.0078	-.0219	.0090	.0036
			2	.0052	-.0079	-.0301	.0094	.0041
			3	.0042	-.0081	-.0378	.0098	.0039
			4	.0041	-.0087	-.0460	.0102	.0042
			5	.0025	-.0087	-.0544	.0107	.0046
			6	.0062	-.0102	-.0640	.0114	.0050

TABLE II.- Continued

LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF

MODELS $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, AND BWT_HT_{VL}

[Body-axis data; M = 4.06; R = 2.7 × 10^6]

i_H	i_V	α	β	C_N	C_m	C_Y	C_n	C_l
(c) BWT_HT_{VL} - Concluded								
0	-6	2	0	0.0534	-0.0206	-0.0142	0.0093	0.0032
			1	.0556	-.0210	-.0226	.0099	.0036
			2	.0565	-.0216	-.0312	.0104	.0039
			3	.0535	-.0211	-.0389	.0109	.0041
			4	.0537	-.0218	-.0479	.0116	.0043
		4	0	.1089	-.0330	-.0147	.0100	.0032
			1	.1100	-.0335	-.0233	.0108	.0037
			2	.1096	-.0331	-.0324	.0114	.0042
		6	0	.1644	-.0461	-.0152	.0109	.0036

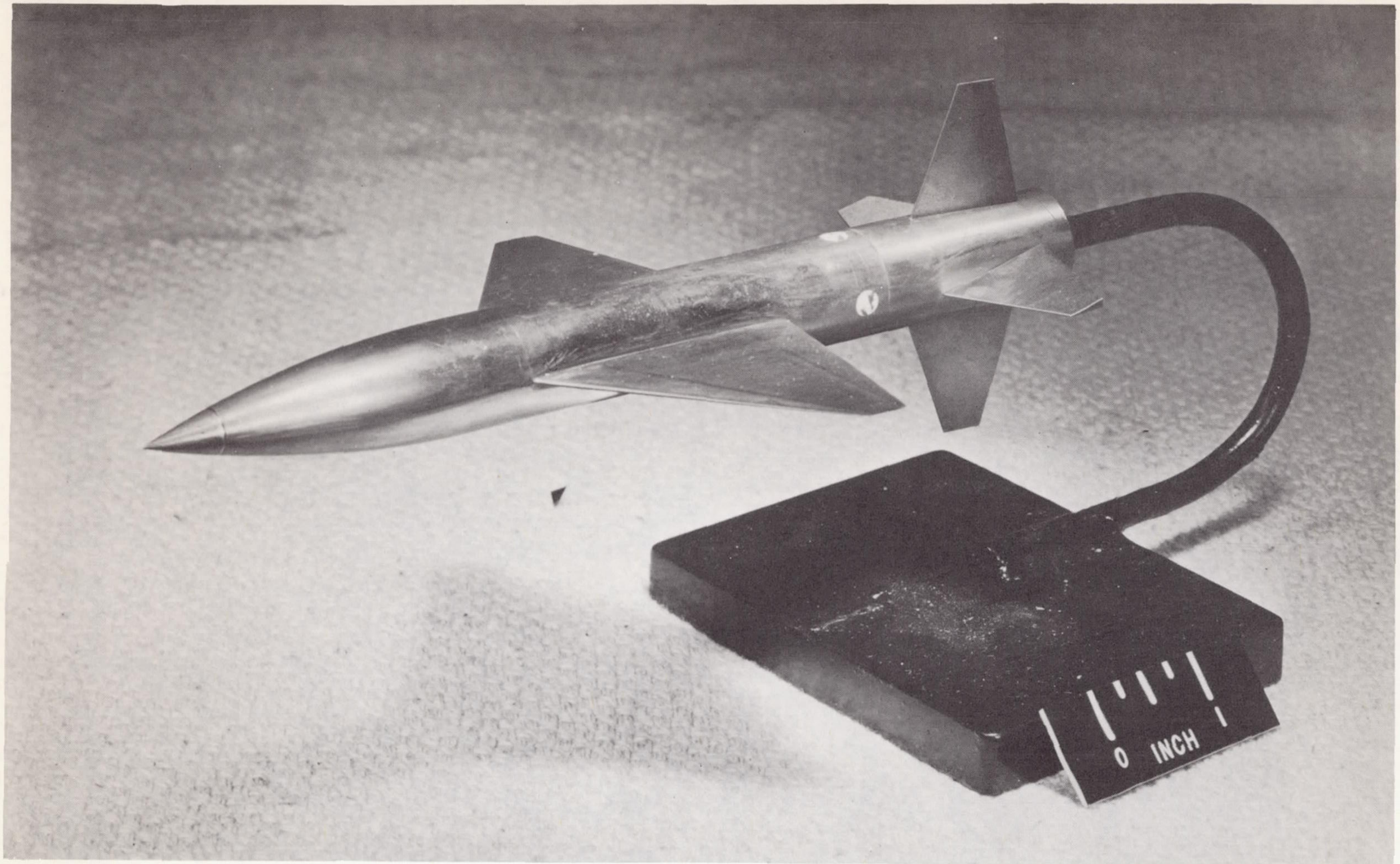


Figure 1.- Photograph of complete model. $i_H = -8^{\circ}$; $i_V = 0^{\circ}$.

L-88040

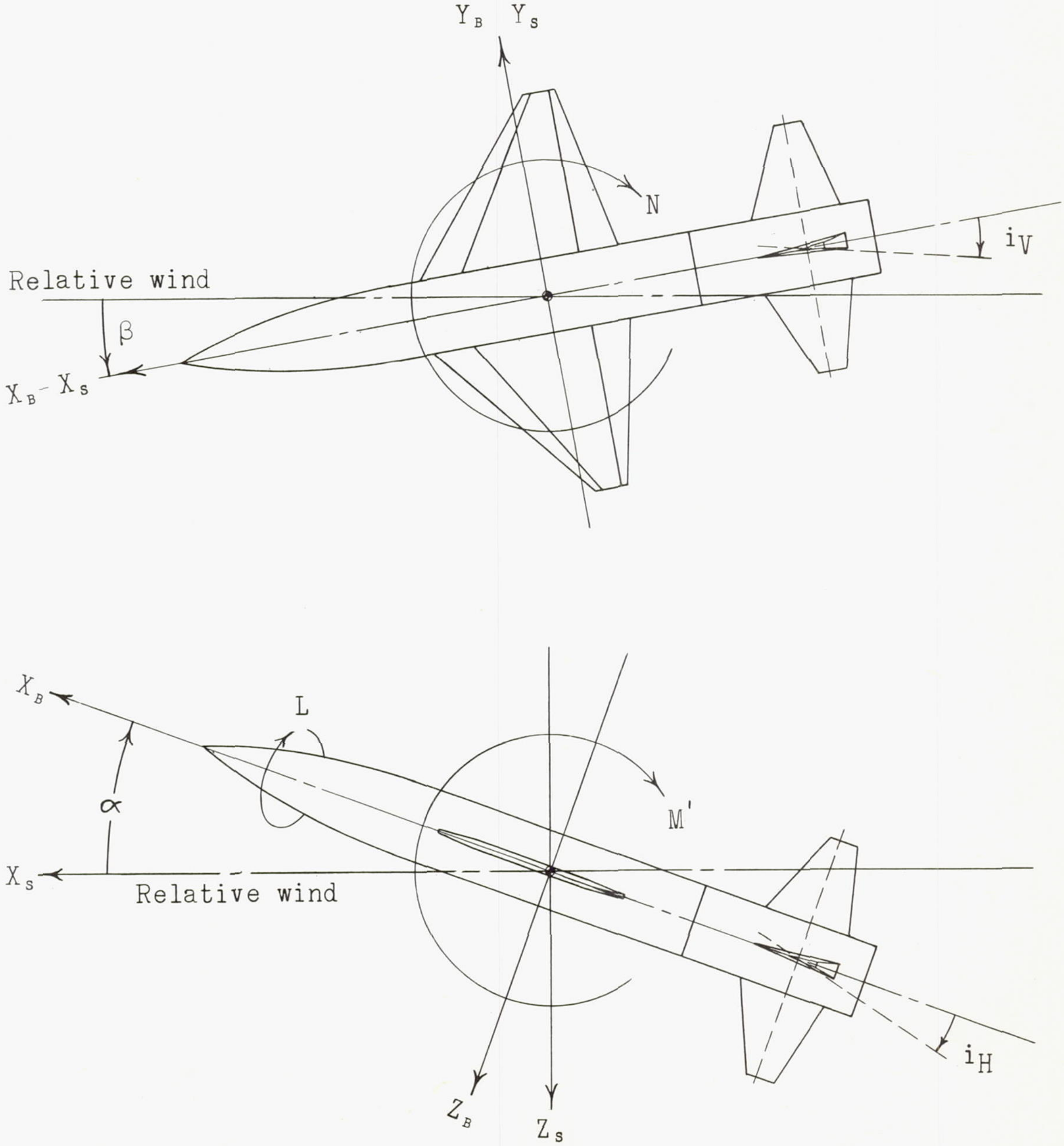


Figure 2.- Systems of reference axes; arrows indicate positive direction. Subscript B indicates body axes; subscript S indicates stability axes.

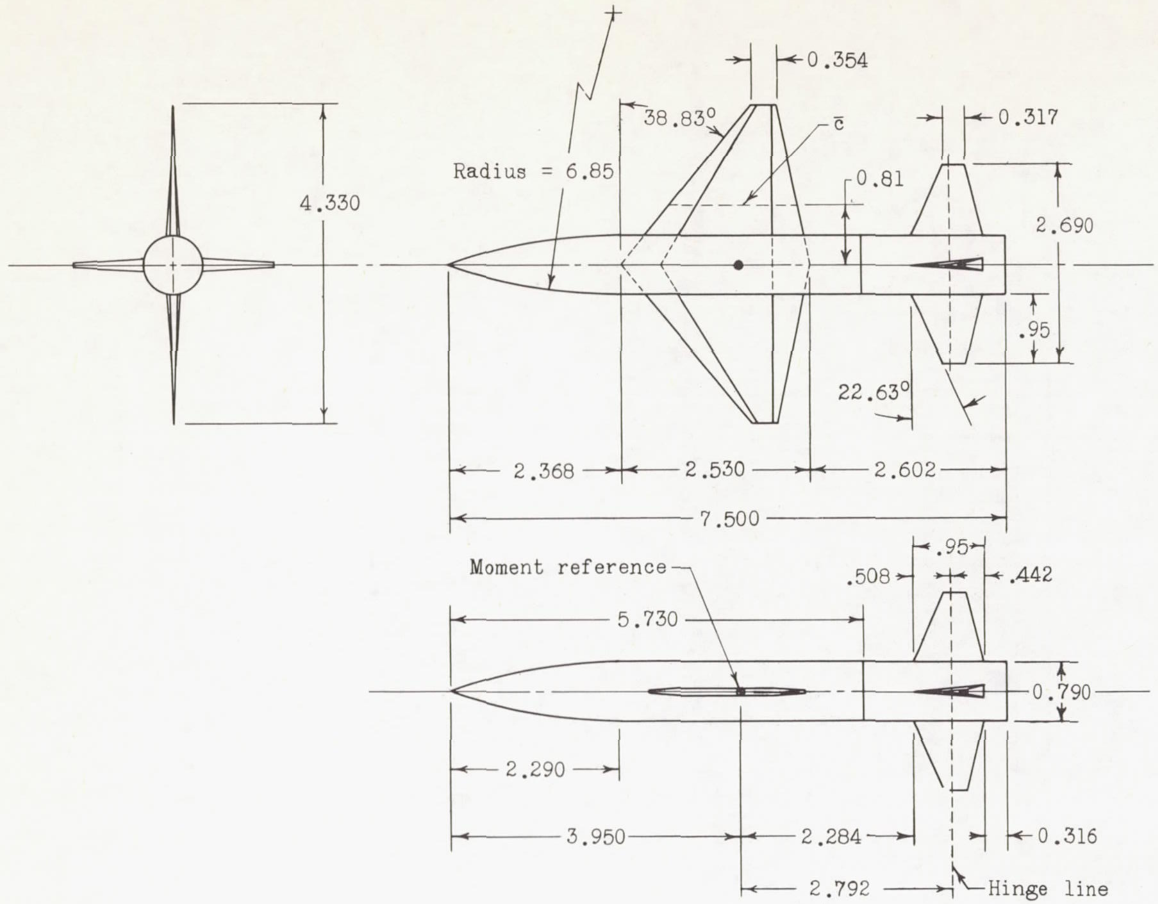
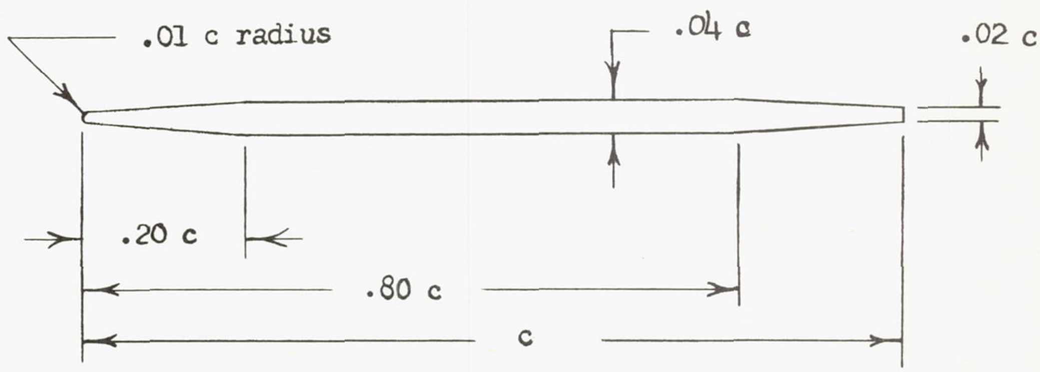
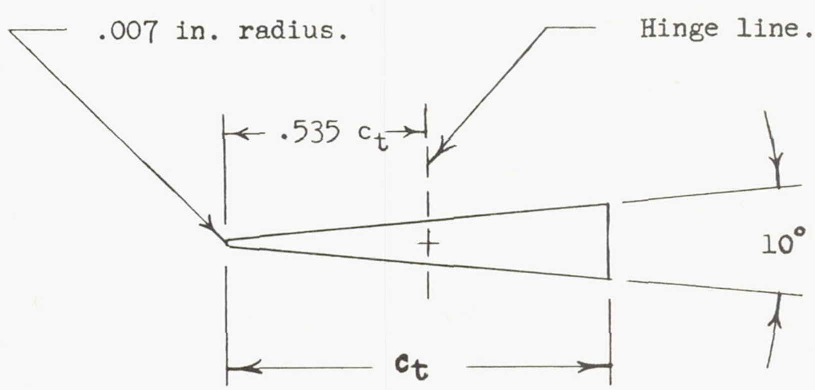


Figure 3.- Wind-tunnel model; all dimensions in inches.



(a) Wing.



(b) Horizontal and vertical tails.

Figure 4.- Wing and tail airfoil sections used on model.

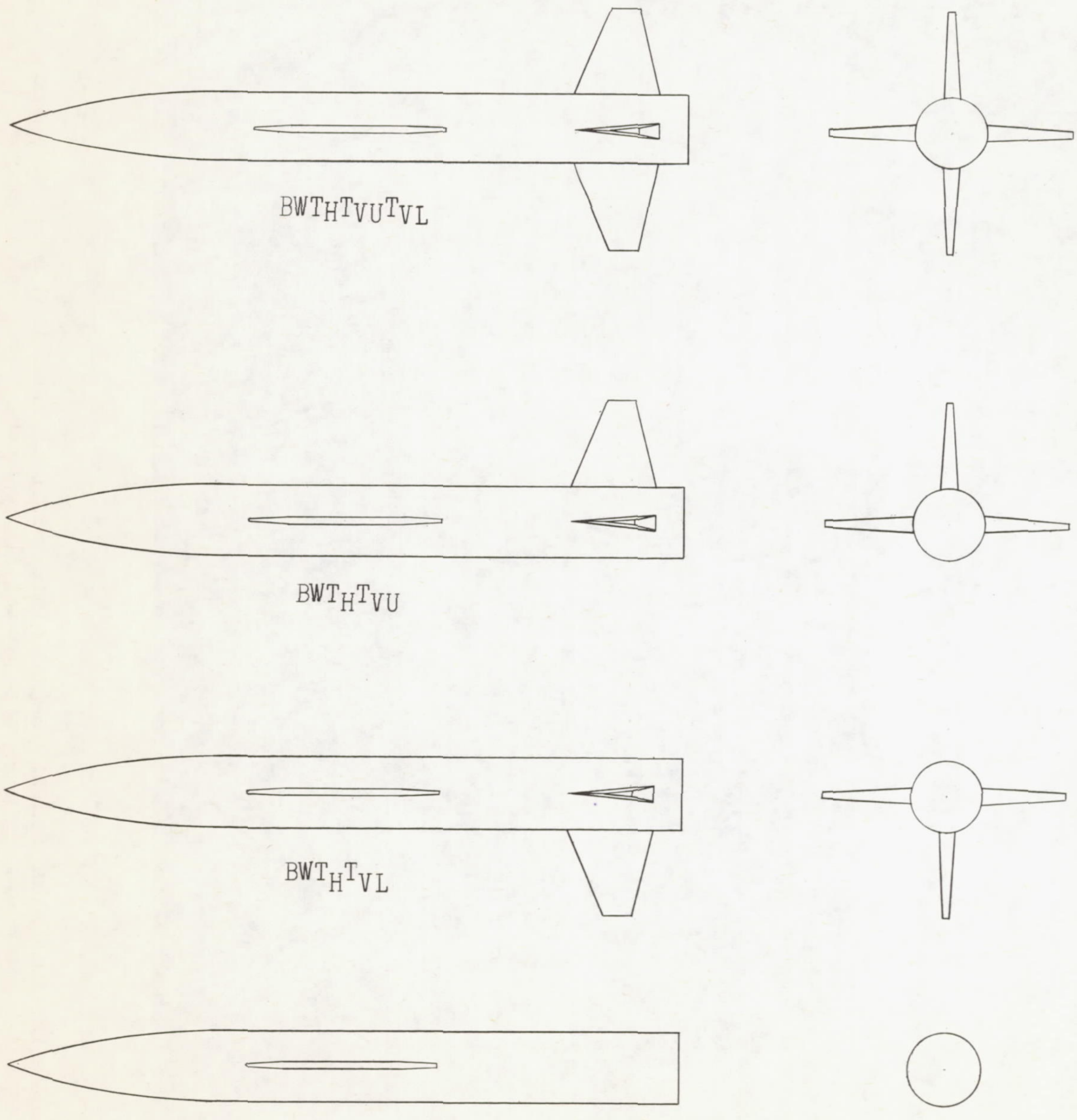
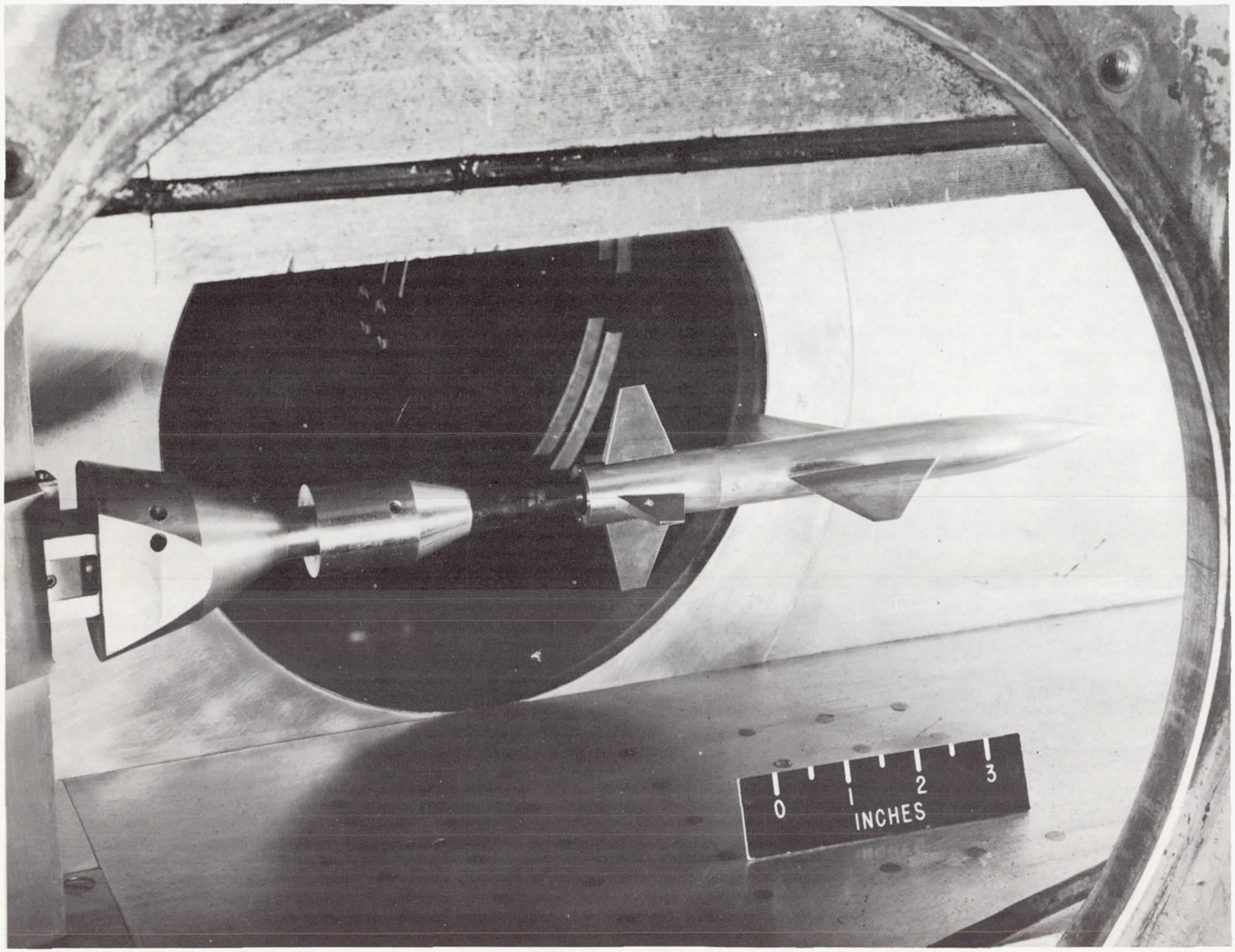


Figure 5.- Model designations.



L-87425

Figure 6.- Installation of the complete model in the Langley 9- by 9-inch Mach number 4 blowdown jet.

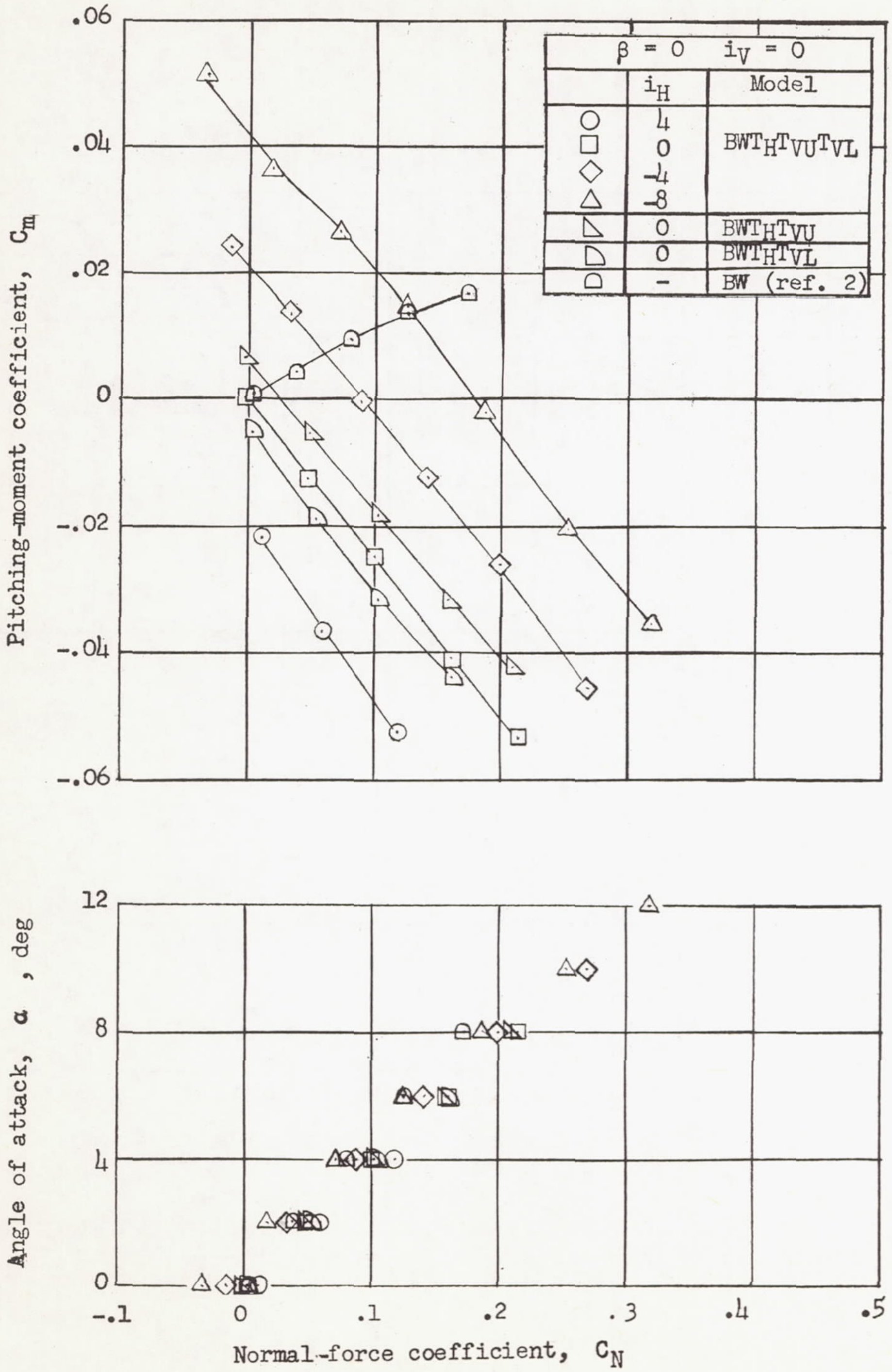


Figure 7.- Variation of the pitching-moment coefficient and angle of attack with normal-force coefficient at various horizontal-tail incidence angles for models $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, and BWT_HT_{VL}. $M = 4.06$; $R = 2.7 \times 10^6$.

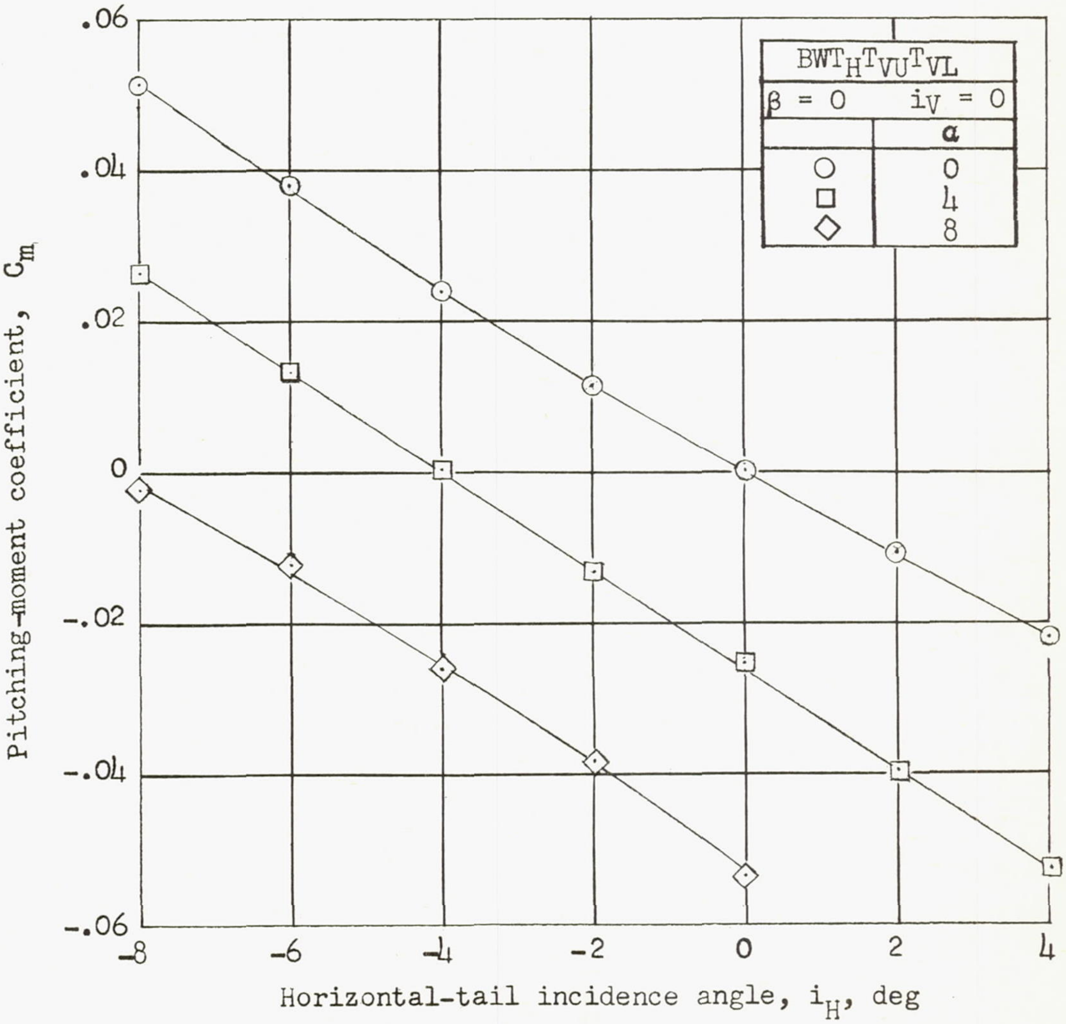


Figure 8.- Variation of pitching-moment coefficient with horizontal-tail incidence angle at various angles of attack for model BWT$_H$T$_{VU}$T$_{VL}$. $M = 4.06$; $R = 2.7 \times 10^6$.

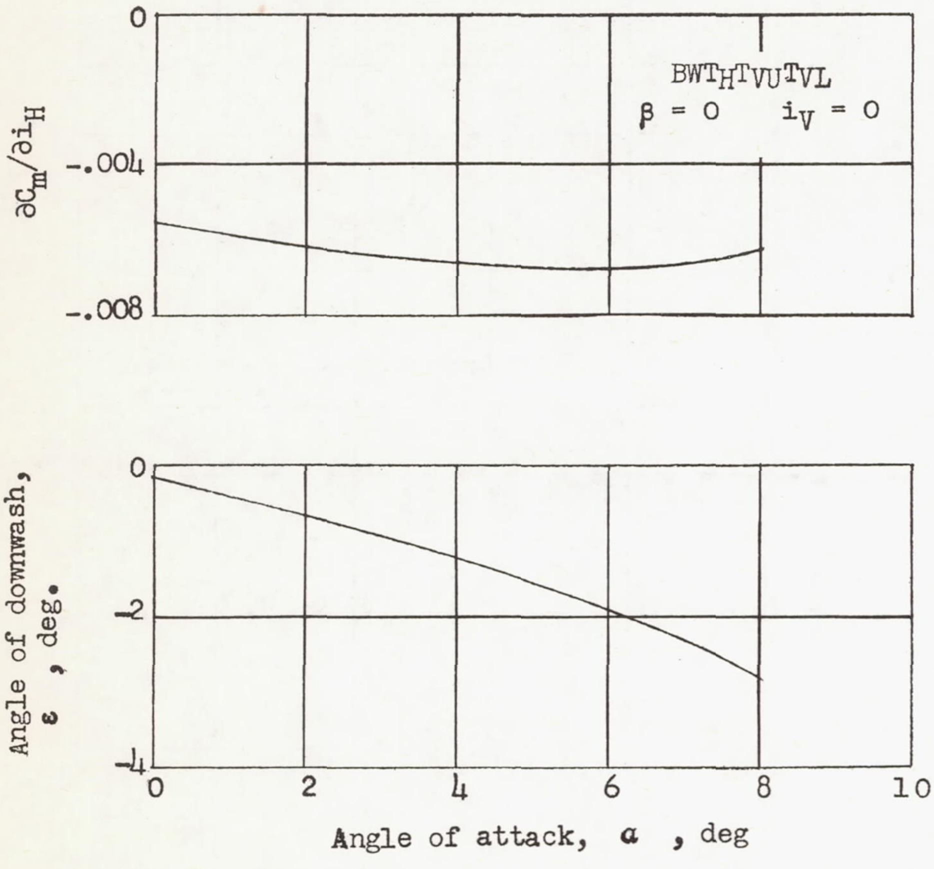


Figure 9.- Variation with angle of attack of the downwash angle and the stabilizer effectiveness parameter $\partial C_m/\partial i_H$ for model BWT$_H$T$_{VU}$T$_{VL}$ at trim conditions. M = 4.06; R = 2.7 × 10^6.

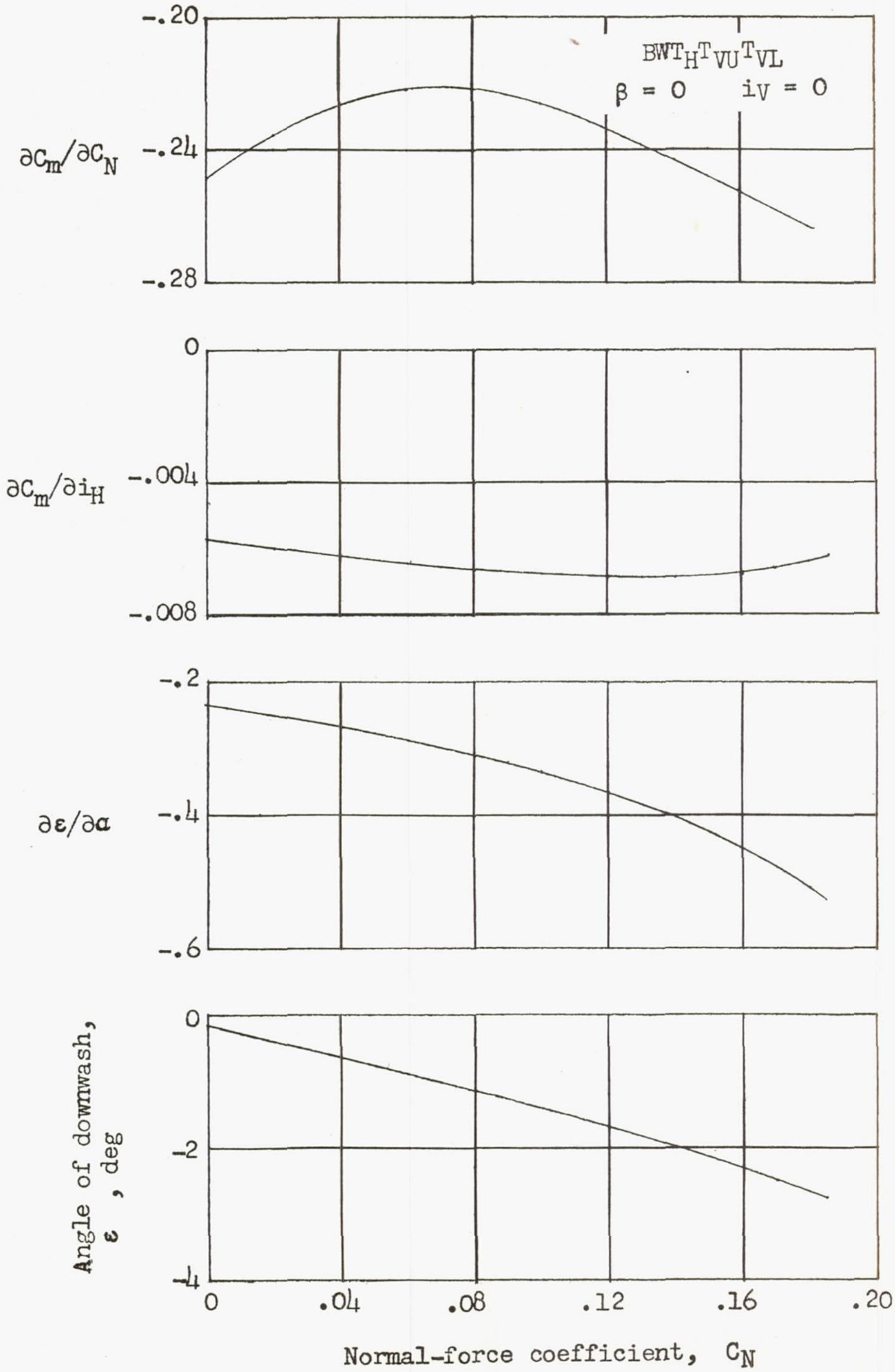


Figure 10.- Variation with normal-force coefficient of the downwash angle and the longitudinal stability parameters $\partial C_m/\partial C_N$, $\partial C_m/\partial i_H$, and $\partial \epsilon/\partial \alpha$ for model $BWT_HT_{VU}T_{VL}$ at trim conditions. $M = 4.06$; $R = 2.7 \times 10^6$.

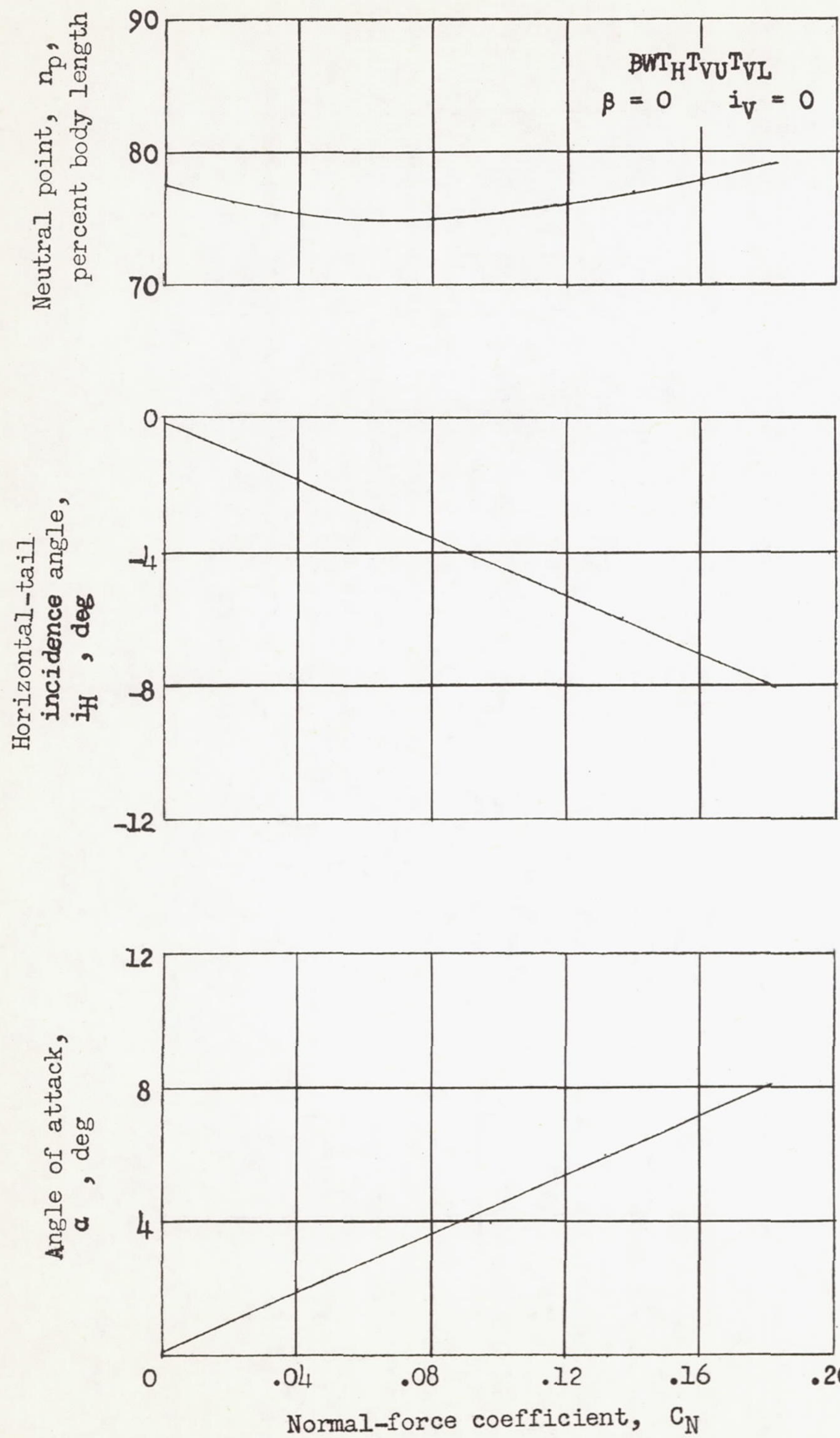
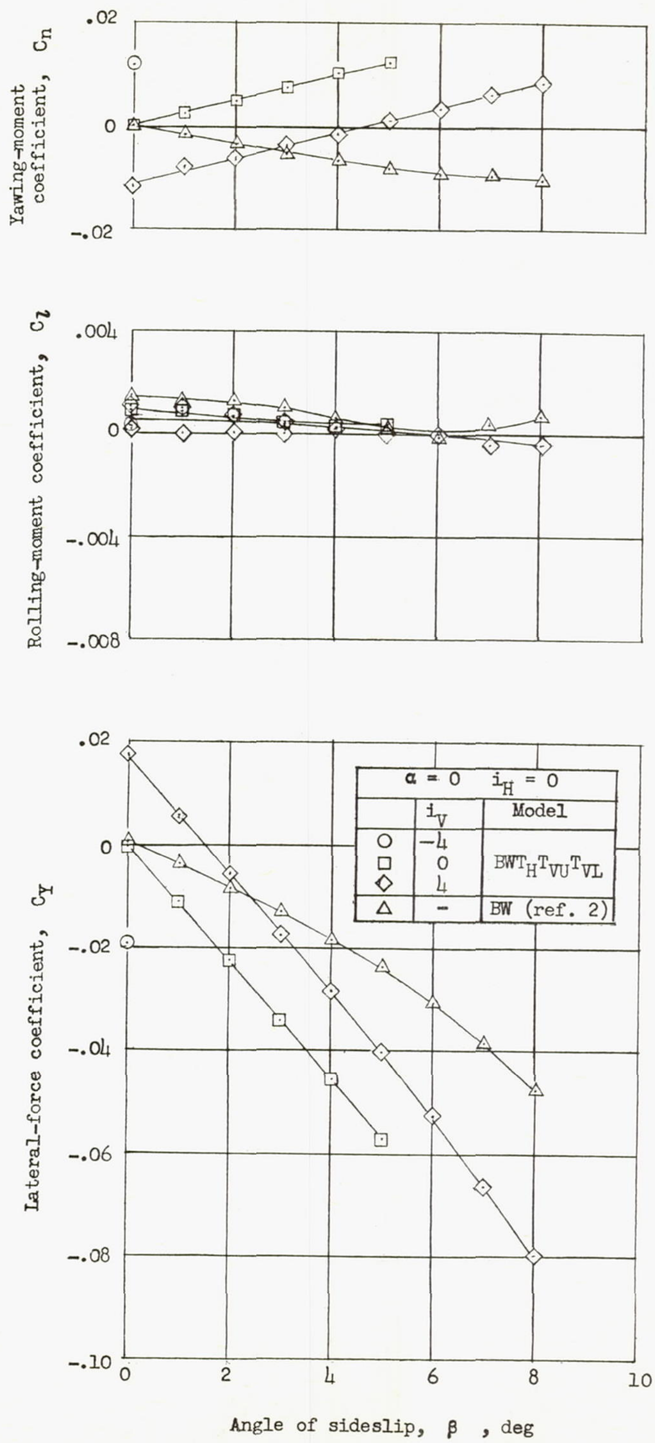
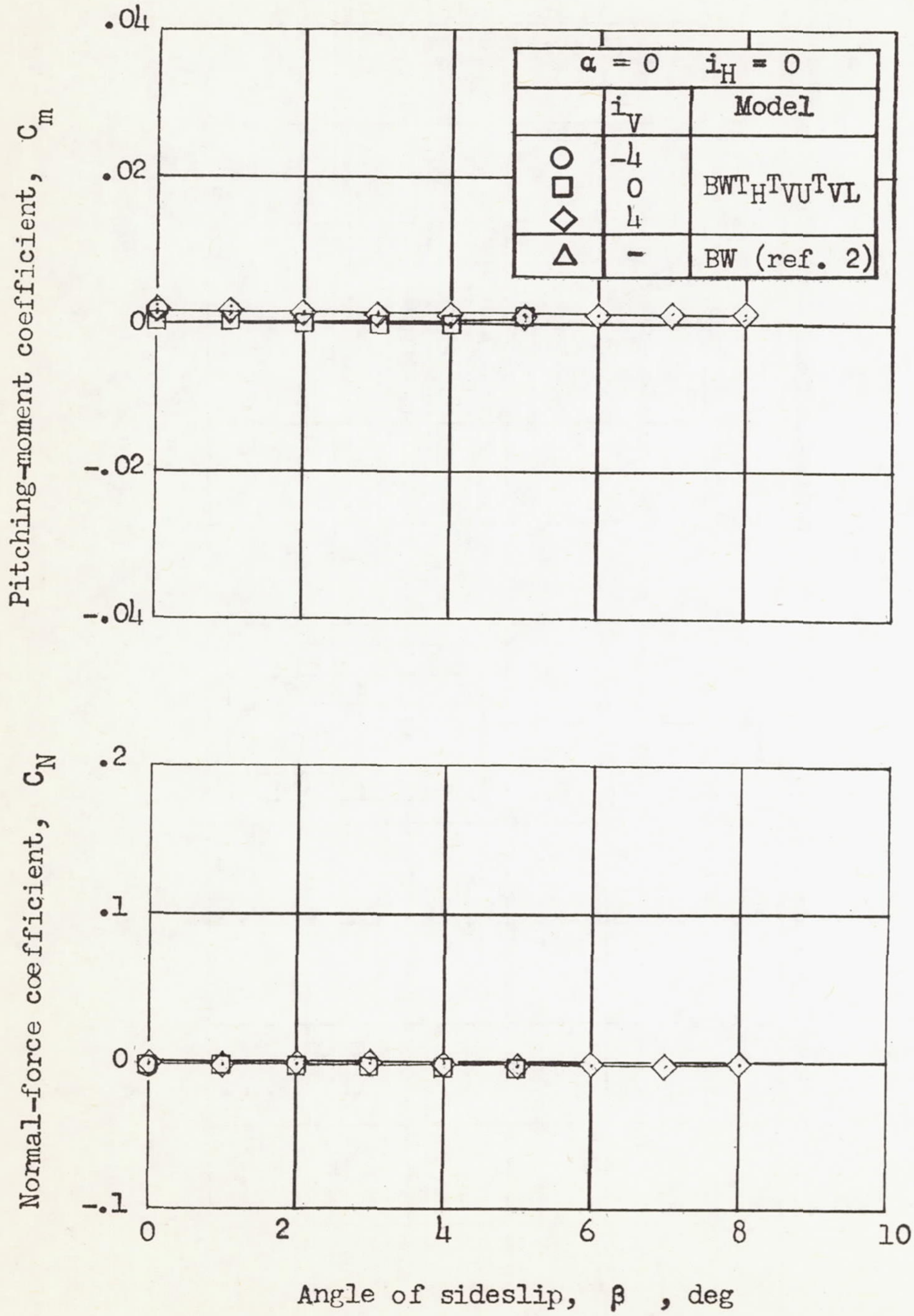


Figure 11.- Variation with normal-force coefficient of the neutral point, horizontal-tail incidence angle, and angle of attack for model $BWT_HT_{VU}T_{VL}$ at trim conditions. $M = 4.06$; $R = 2.7 \times 10^6$.



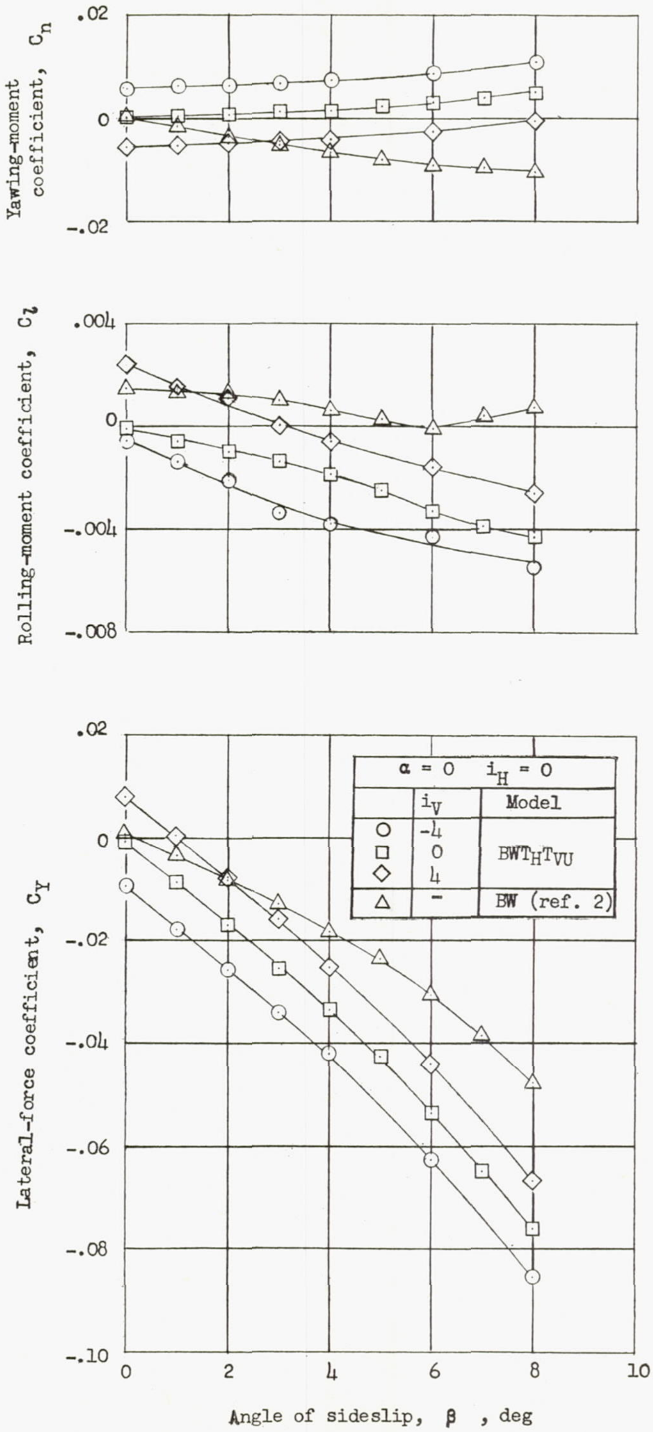
(a) Lateral characteristics.

Figure 12.- Variation with sideslip angle of the lateral and longitudinal characteristics of model $BWT_HT_{VU}T_{VL}$ at various vertical-tail incidence angles.



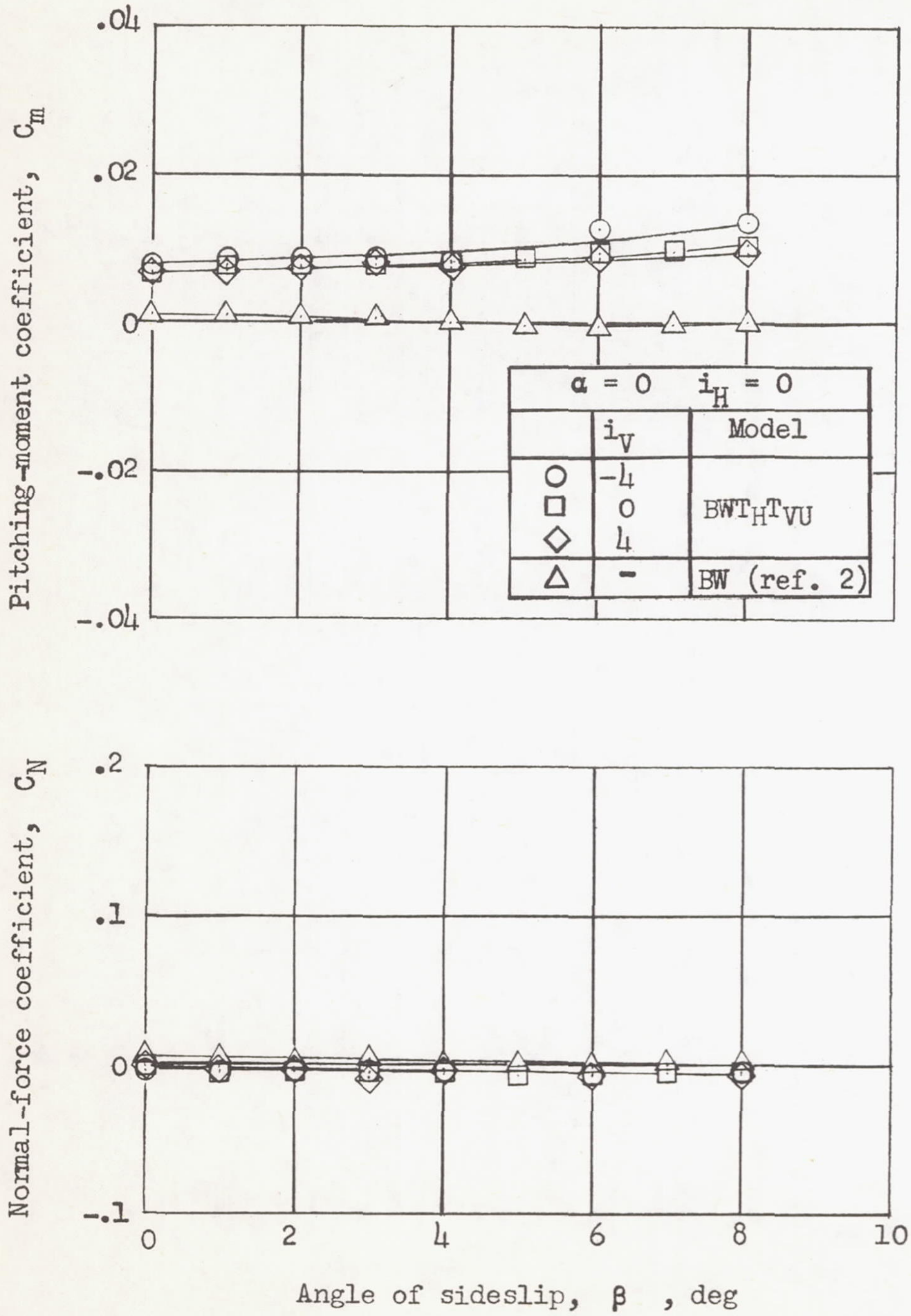
(b) Longitudinal characteristics.

Figure 12.- Concluded.



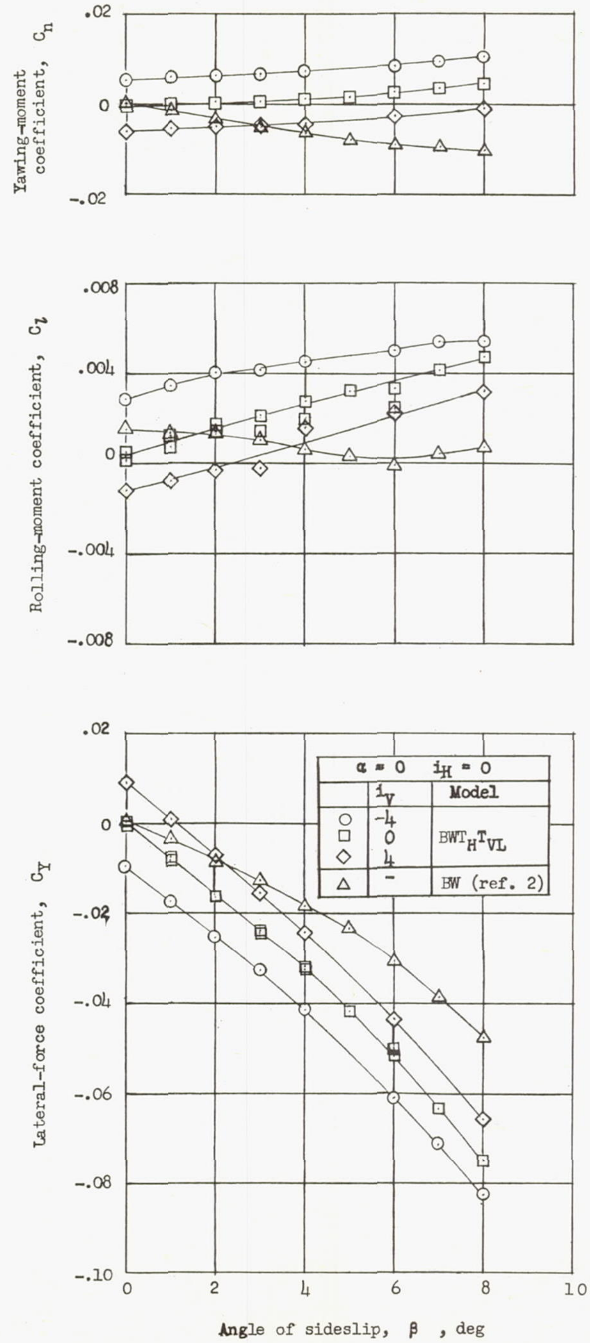
(a) Lateral characteristics.

Figure 13.- Variation with sideslip angle of the lateral and longitudinal characteristics of model BWT_HT_{VU} at various vertical-tail incidence angles.



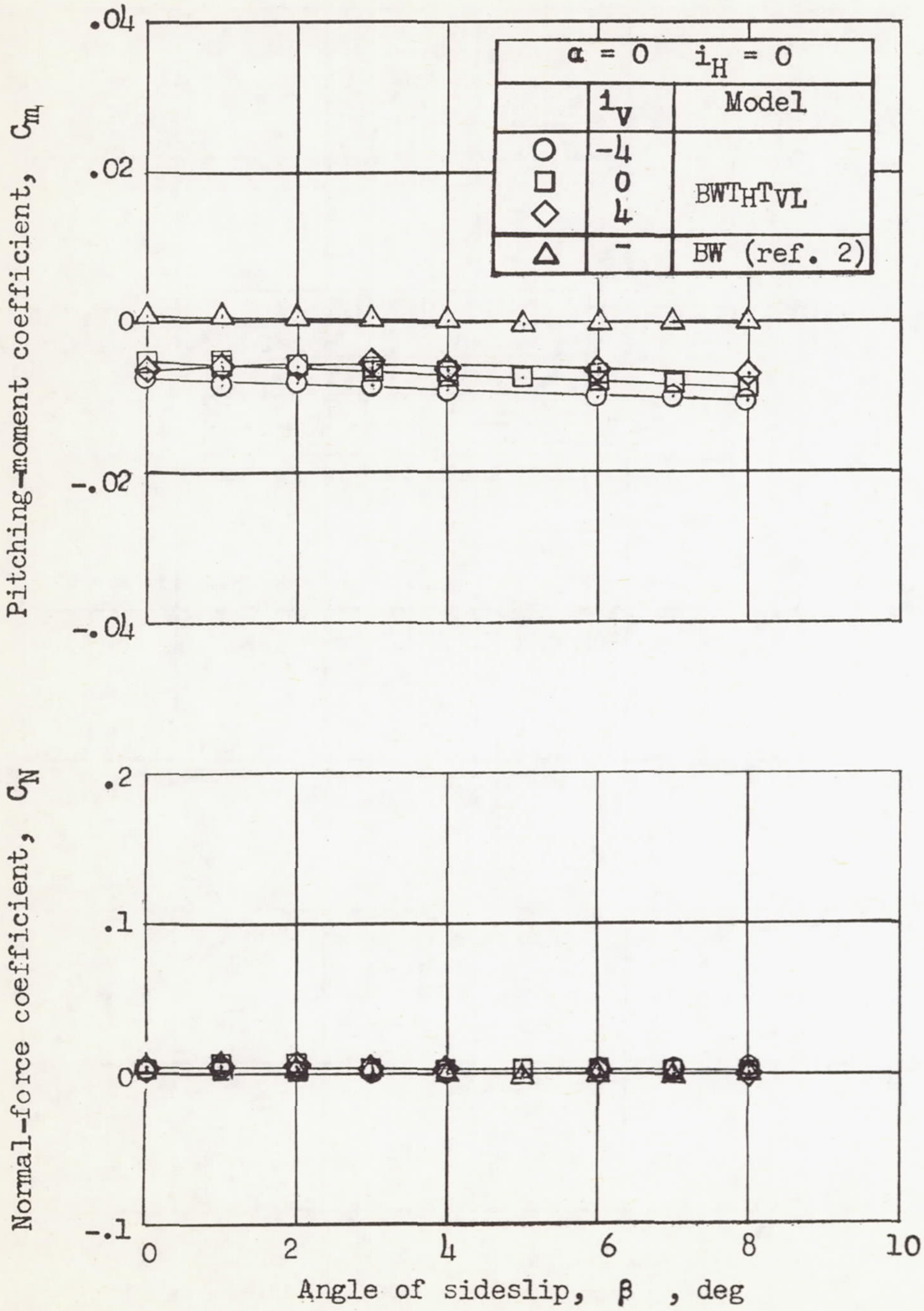
(b) Longitudinal characteristics.

Figure 13.- Concluded.



(a) Lateral characteristics.

Figure 14.- Variation with sideslip angle of the lateral and longitudinal characteristics of model BWT_HT_{VL} at various vertical-tail incidence angles.



(b) Longitudinal characteristics.

Figure 14.- Concluded.

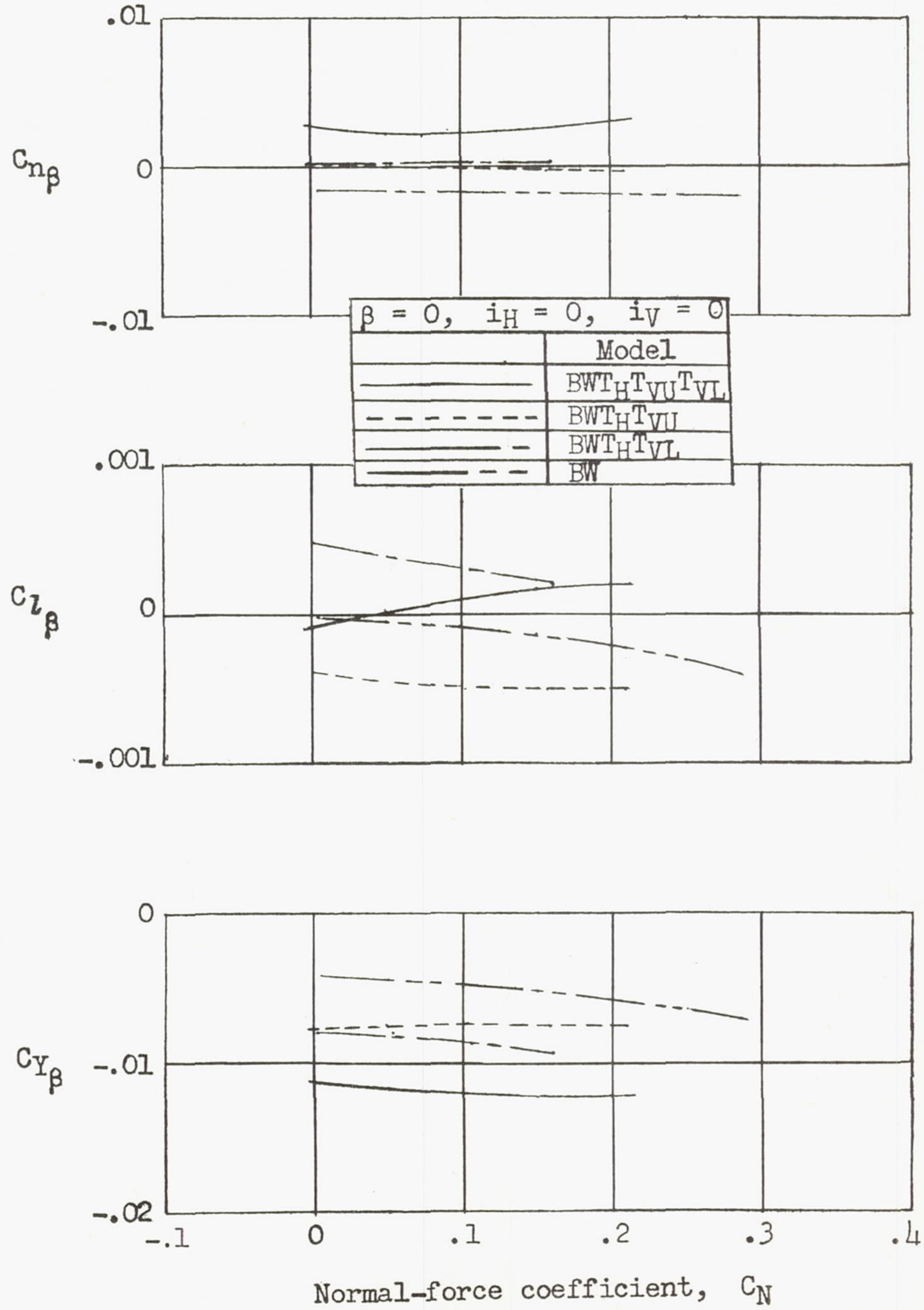
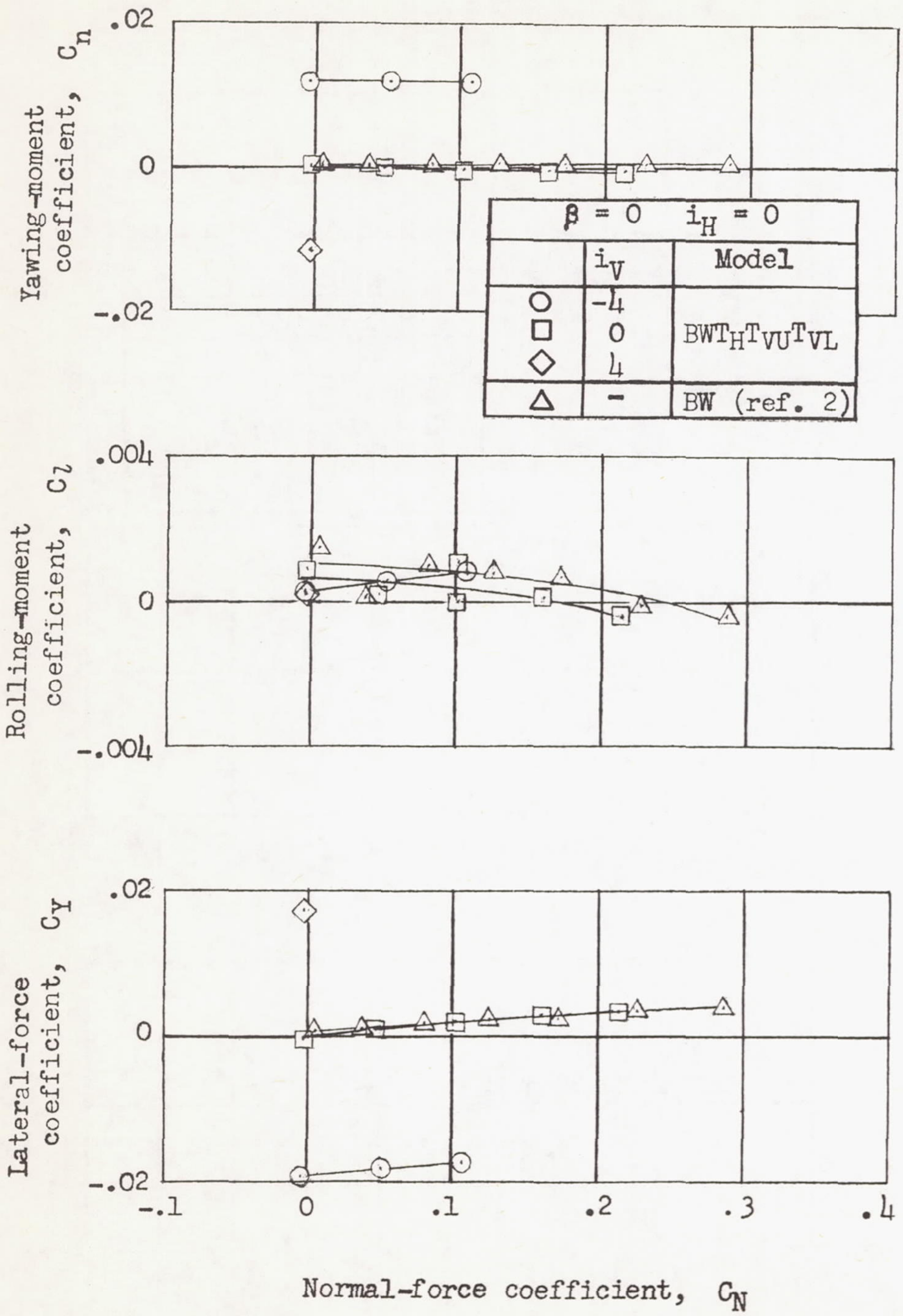
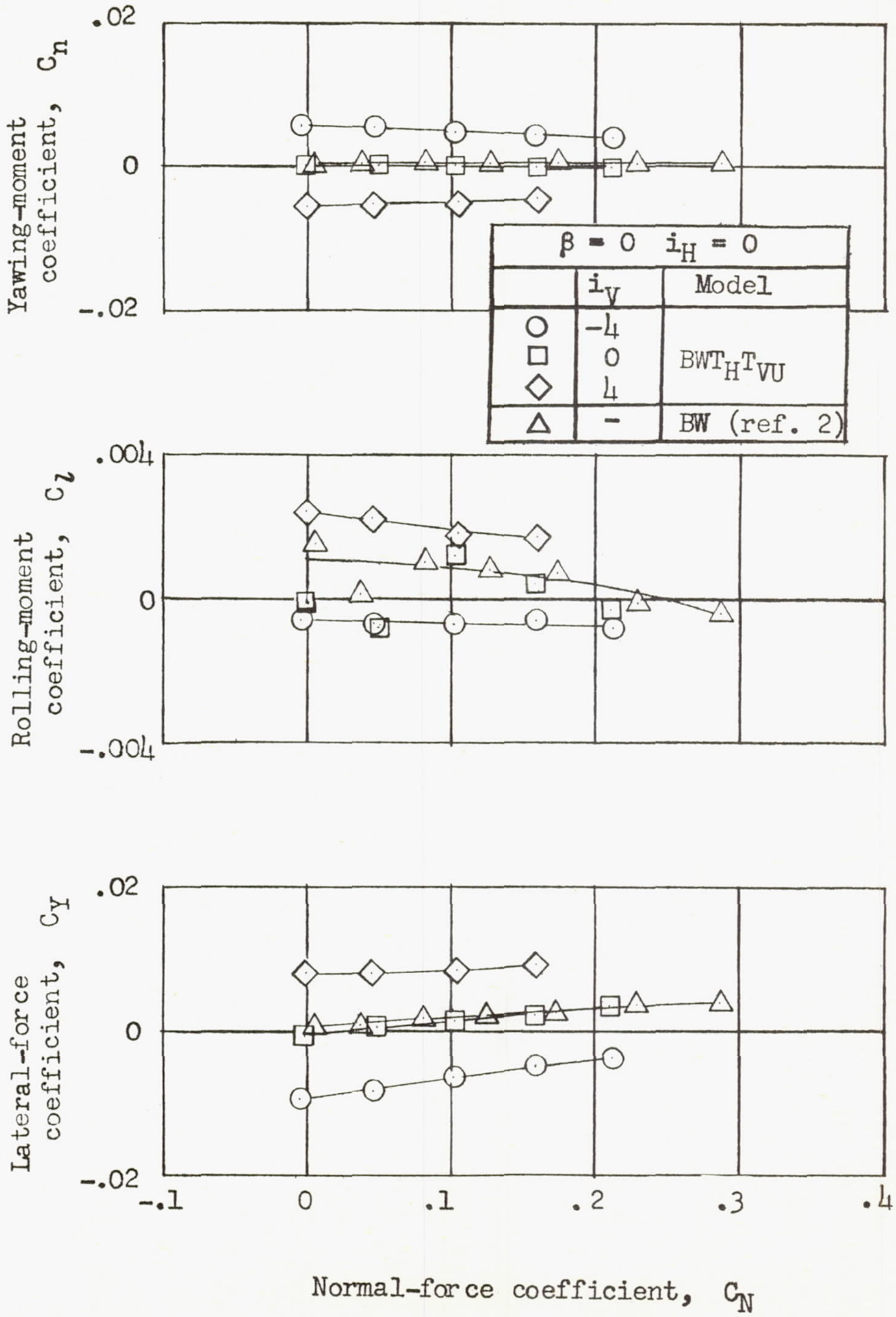


Figure 15.- Variation with normal-force coefficient of the lateral stability parameters C_{n_β}, C_{l_β}, and C_{Y_β} for models $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, BWT_HT_{VL}, and BW. $M = 4.06$; $R = 2.7 \times 10^6$.



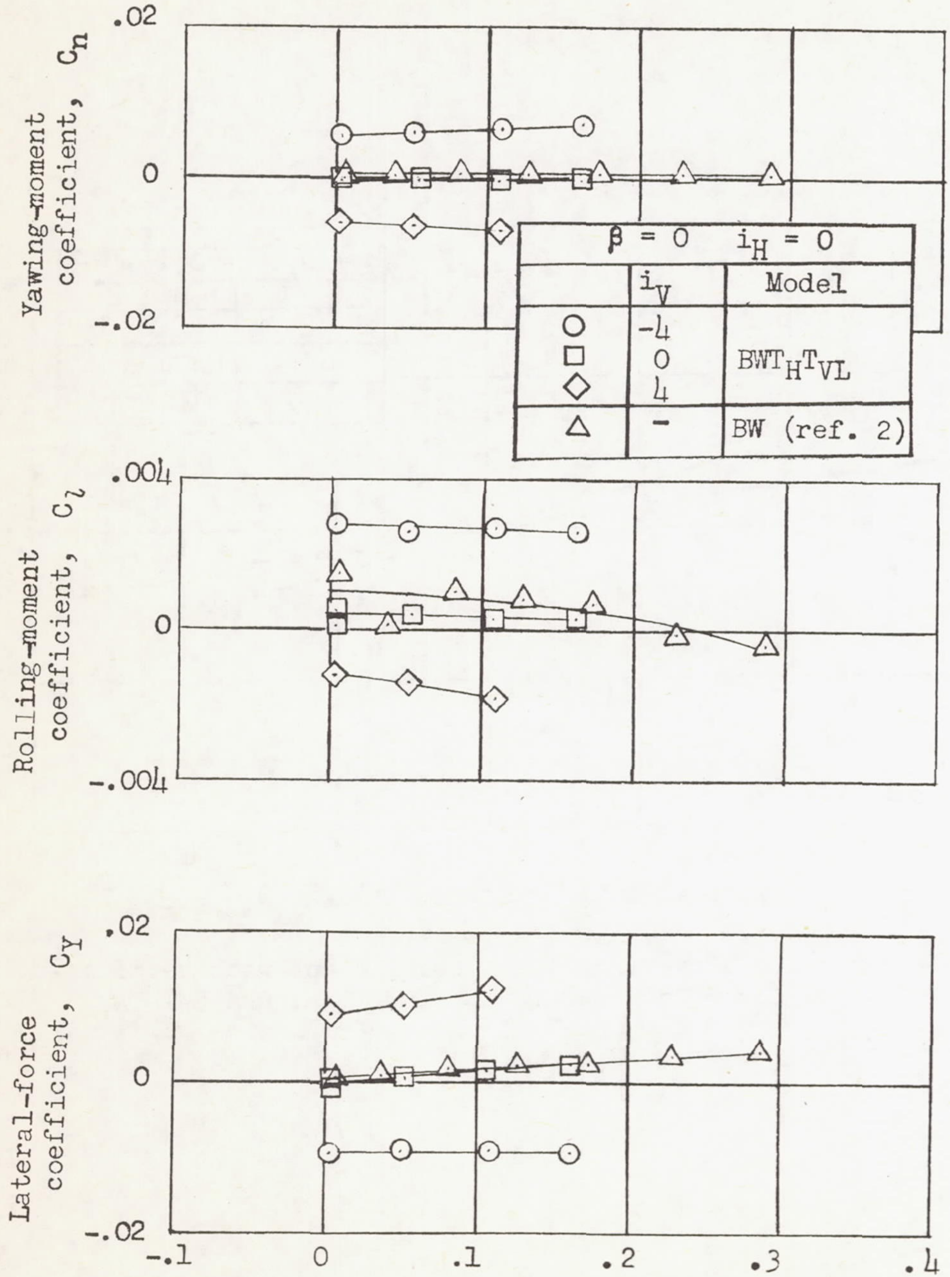
(a) Model $BWT_HT_{VU}T_{VL}$.

Figure 16.- Variation with normal-force coefficient of the lateral characteristics of models $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, BWT_HT_{VL}, and BW at various vertical-tail incidence angles. $M = 4.04$; $R = 2.7 \times 10^6$.



(b) Model BWT_HT_{VU}.

Figure 16.- Continued.



(c) Model BWT_HT_{VL}.

Figure 16.- Concluded.

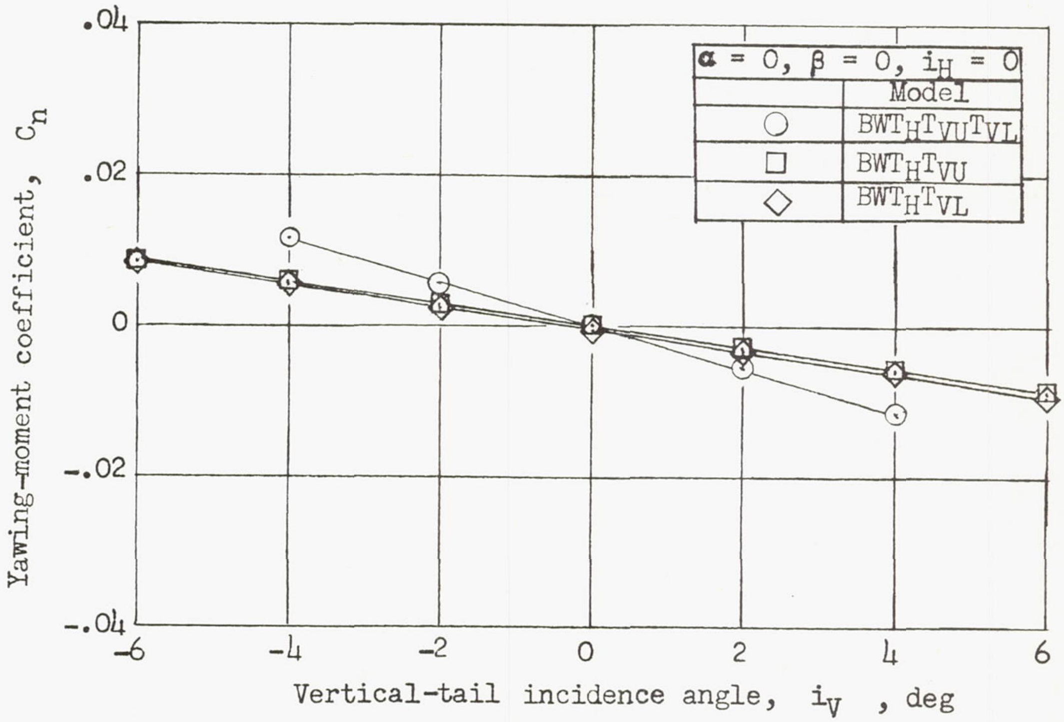


Figure 17.- Variation of yawing-moment coefficient with vertical-tail incidence angle for models $BWT_HT_{VU}T_{VL}$, BWT_HT_{VU}, and BWT_HT_{VL}. $M = 4.06$; $R = 2.7 \times 10^6$.